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ANNOUNCEMENTS.

FEILDEN'S MAGAZINE is published at the *beginning* of every month.

In consequence of the large number of pages to be prepared and passed for press, the careful nature of the printing required for high-class production, the advance arrangements made for extensive circulation, and in order to facilitate departmental business, observance of the following rules is necessary :—

Literary Matter to reach the offices not later than the 1st of the month (as much earlier as possible) previous to date of publication. Communications to be addressed "Editorial Department."

Advertisements intended for insertion in next issue must be received not later than the 15th of the month (as much earlier as possible), to insure correct classification. All communications respecting same to be marked "Business Department." Advertising Rates, on application, regulated according to positions available.

Subscriptions and letters with reference to copies to be marked "Subscription Department."

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For Buyers' Guide, Index to Advertisers, and Directory of leading British Manufacturers, see pages ii. and iv. of second cover, and pages iii. to xiv. (in first part of Magazine).

All communications to be addressed

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* * *

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THE EDITOR will be pleased to consider Literary Contributions dealing with subjects within the purview of this Magazine, and to make satisfactory arrangements with Contributors if MSS. be accepted for publication. High-class engravings from photos and drawings will be prepared free of cost to the writer.

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This issue is the *second* number of Vol. III.

Feilden's Magazine

With this issue celebrates its first birthday, and, as foreshadowed in the last number, I am placing in the hands of my supporters an edition which I venture to hope and believe will worthily uphold the high standard attained by this publication.

On this occasion I shall claim the indulgence of my supporters for a few minutes in order to give a brief resumé of the past achievements of the Magazine, and to outline, in a measure, the programme this journal will present to its readers during the ensuing twelve months.

First let me record my sense of the generous appreciation which has been accorded the Magazine, an appreciation which I hope I am not egotistical in assuming is well deserved, for I have endeavoured both with heart and mind to give British engineers and manufacturers something which they never before possessed, *i.e.*, an organ having as its fundamental policy the conscientious furtherance of British trade and prestige the world over, without any regard to an ulterior object beyond the usefulness of the publication in the legitimate exploitation of business.

From its inception, this Magazine was acknowledged as a startling and novel departure from old, conservative and orthodox lines and was recognised as a future power. It was heralded by the responsible Press of this country as something needed—long needed. The only disquieting suggestions thrown out were that it might not be possible to keep up so obviously costly a periodical and so pronouncedly bold and effective a programme. Time proves all things. We are here to-day, on our first anniversary, firmly established, wielding a power and influence admittedly stronger and more forceful than any other industrial-engineering publication in Great Britain.

OUR "MILITANTLY BRITISH" POLICY.

This has naturally given rise in more than one quarter to certain misgivings, and some of the leading dailies in the country have gone so far as to adversely criticise it, evidently, however, without a full appreciation of its meaning. As pointed out in our second issue in reply to these critics, and as was generally recognised and adequately expressed by a leading daily paper, "FEILDEN'S MAGAZINE is Militantly British, but it is the Imperialism of commerce and kinship, not of militarism," not a policy of aggressiveness but a policy of assertiveness and strength in connection with the promotion and furtherance of British industrial interests before the world.

LITERARY CONTENTS.

The literary contents of the Magazine have been framed with the object of presenting the best, most instructive, and most useful reading matter, regardless of cost. The sections of the paper have been thought out and selected with the greatest care, based upon long practical experience and a close observation of the tendency of the times. In the leading articles and editorials we have fearlessly stated our views and presented what, in our judgment and discernment, has appeared to be right. There will be no deviation from this course, and if stringent criticism be necessary, it will be forthcoming, but in fair comment always.

It is satisfactory to find in this connection that our opinion has been more often than not acted upon in high quarters, and it is worthy of note that the amalgamation of the Welsbach and Sunlight Incandescent Gas Lighting Companies, the establishment of a Commercial Department of the Board of Trade, the founding of a school of Chinese, and the removal of apparent anomalies in regard to the British allotments at the Paris Exhibition, all followed the

publication of articles in this Magazine upon these subjects and to which public attention was prominently directed.

ORIGINAL ARTICLES BY EXPERTS.

The number of these and the variety of subjects contributed by world-renowned writers have commanded wide appreciation, both in professional and manufacturing circles. In this department the Magazine has endeavoured to secure the most representative selection, and our future arrangements provide for articles, if possible, of a still higher technical value and character.

NEW MACHINERY, APPLIANCES, ETC.

In this section a consideration of only the newest and most meritorious mechanical devices has found a place, and the avidity with which representative firms seek our columns is sufficient evidence of the value of our published descriptions and of the public pronouncement of our opinions.

WORKSHOP PRACTICE.

The opportunity which the establishment of this section gives to mechanics in our great industrial establishments to bring forward the results of their inventive capacity and resourcefulness, should prove to be not only a stimulus to the men themselves but to employers also in encouraging their employées to communicate their practical ideas.

WORLD'S PRESS.

The value of this systematic record of the march of events and research to the professional man, to the manufacturing engineer, or to anyone interested in any particular branch of science or technology must be too apparent to need any explanation.

OUR CIRCULATION.

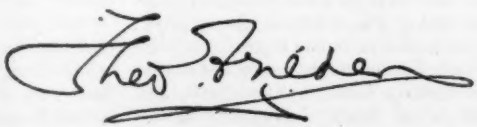
Never before in the history of technical journalism has a genuine sale equal to that of FEILDEN'S MAGAZINE been secured in the same space of time, and there is possibly not another engineering monthly in the world which is to-day in a position to prove an average sale of 10,000 copies per issue. Further than this, I claim that the circulation of the Magazine is the most representative extant, and the wide area covered thereby renders it doubly valuable to its supporters. Wherever the English tongue is spoken, and in very many places where it is not, FEILDEN'S MAGAZINE will be found strongly in evidence in commercial and industrial circles. Unprecedented as the sale already is for a technical publication, it is still steadily increasing.

TYPOGRAPHY AND ILLUSTRATIONS.

In this respect the universal opinion is that FEILDEN'S MAGAZINE cannot be surpassed. The Magazine, however, speaks for itself.

A FINAL WORD.

No one unversed in the art of producing a responsible journal, particularly of a technical character, can adequately appreciate what labour, thought, anxiety, and expense are involved in the production of an important publication of this nature. Any help, direct or otherwise, therefore, that my good friends can accord me will be greatly appreciated, and will tend to the further success of this publication, which I am endeavouring daily to make increasingly worthy of their support by the advancement of their interests and those of our country.



American Competition.

In our last issue we directed attention to a letter by Sir Lowthian Bell, which expressed the opinion that, so far as large iron and steel producing works are concerned, the special correspondent of *The Times* had scarcely done full justice to British metallurgists and engineers. Mr. Stephen Jeans has also suggested on one or two recent occasions that the condition of things in this country as to competition is by no means so serious as the author of the articles in *The Times* on "American Engineering Competition," is disposed to make it appear.

It may well be, and we are inclined to believe it is correct, that in the production of iron and steel our leading ironmasters have little to learn from the United States or elsewhere. At the same time it is an undoubted fact that many of the smaller ironworks and foundries in this country are altogether behind the times both in equipment and business organisation. The day of makeshift appliances and haphazard methods has gone by, and those who continue to make use of such must expect to find their trade gradually absorbed by more progressive business firms. We do not now propose to pursue the discussion upon competition experienced by iron producing establishments, but to bring forward some matters relative to structural work and to see whether in this department of engineering there are lessons to be learnt from American practice.

Some of our more enlightened manufacturers are fully aware of the enormous developments exhibited throughout the United States in constructive steel work. Unfortunately, however, the great majority of British engineers know very little of what has taken and is still taking place across the Atlantic. They remain true to the traditions of the past, and cherish the mistaken belief that Great Britain must, in any event, and somehow or other always maintain a position of supremacy. Such people forget that the pre-eminence of their country was originally established as the direct result of superior intelligence and facilities for production. They also forget the progress made by other countries and are cheerfully oblivious of the fact that home, colonial and foreign markets are slipping from their grasp, inch by inch, and year by year. Too many of our manufacturers have gained money and lost the energy necessary for the progressive extension of trade. Many of their sons are better qualified by education for spending than for making money, and others who appreciate the necessity for improvements are restrained by the conservatism of their fathers. Every year a certain number of old-fashioned firms disappear from view, and there are others for whom a similar fate is in store, simply because their managers refuse to move with the times, or, perhaps, because the proprietors decline to expend the capital necessary for the provision of new plant or for the building and equipment of new premises. Whilst Britain for a great part is gently dreaming in a sort of middle-aged fool's paradise, other nations, filled with the energy of youth, and fully alive to the conditions necessary for success, are rapidly taking front places in all parts of the world. Some facts stated by the commissioner of *The Times* are sufficiently startling in themselves to awaken even some of our sleepers.

For instance, we find one American firm has built "a railway bridge across a river as wide as the Thames at London, simply to make communication between two of its factories." Such an undertaking would never be dreamed of in this country, on account of the heavy outlay involved. Perhaps it would not be in America were it not for the fact that bridge work has been so thoroughly systematised as to reduce the cost of construction to the lowest possible limits. Of course, large num-

bers of bridges are built every year in the United States, owing to the requirements of various railway companies, and there is, therefore, something like a wholesale trade in such structures. But this fact alone is not sufficient to account for the favourable position occupied by American bridge builders. If we take the requirements of the United Kingdom and the Colonies, we find a very large number of bridges is actually built in Great Britain, and no doubt many more might be constructed for other countries if prices were favourable. The unfortunate thing is that so many different designs prevail, and, to a large extent, unnecessarily. Every railway engineer and every civil engineer thinks it necessary to demonstrate his ability by preparing his own designs for the bridges to be erected on any work in which he is engaged. The actual builder of the bridges may be a man of considerable ability and practical knowledge of such work, but he is merely regarded as a contractor whose duty it is to follow instructions blindly and to ask no questions. There are many engineering firms quite capable of designing bridges, but as they are not asked to do so, it is not easy for them to attempt to introduce standard designs. Consequently, the adoption of special tools and appliances is considerably limited, and as each structure has to be treated separately the builder cannot reduce the cost of manufacture by preparing the different details in large quantities, as is usual in other classes of engineering work. Under existing conditions bridges must cost more and take longer to build in Great Britain than in countries where standardisation is the rule. Constructional engineers are not entirely to be blamed for this state of things, which results chiefly from the course of action adopted by the public, and the various consulting engineers employed by them. One of the advantages which it is to be hoped may result from the recent series of articles in *The Times* is that the public as well as engineers may learn in what manner the industrial progress of the empire may be hindered in one direction or another by continued adherence to methods hitherto followed. To show more clearly the desirability of some change, so far as structural work is concerned, we may mention one or two facts quoted in *The Times* article on "Structural Steel Work." It is said to be "one of the strong points of the American system that those who contract for structural work are largely producers of steel. The Carnegie Company have over a hundred draughtsmen in their Pittsburg office, and they will furnish designs for a building containing thousands of tons of steel and make no charge if they get the contract for the material." This is in marked contrast to our own system, in which an architect gets heavy fees from his client, whilst the contractor generally prepares the designs, free of charge to the architect. Yet the client would not feel safe in dealing directly with the contractor. Specialists are engaged by all the large engineering firms in the United States, and although consulting engineers are found in practice on their own account "the work is far more in the hands of men who have had wide experience in the execution of work. Therefore, practice and theory—using the terms in their conventional sense—go more often hand in hand." It is rumoured that purely designing engineers, in this country, have been known to get into serious difficulties during the execution of important works, and that they have only been extricated by invoking the aid of the contractor. *The Times* correspondent thinks "the example we had in this country not long since of the design of an important bridge being recast by the contractor's engineer, because it would have been impossible to erect it as originally planned, could not occur in America." Most likely it could not; for in

America the bridge builder is a specialist. In our own country, bridges and other important works are often planned by men in public positions who are expected to be, but are not, specialists in a dozen departments of their profession.

It is not altogether fair to blame the public and consulting engineers alone for the fact that bridges are not bought from stock designs as are boilers and steam engines. No commercial undertaking is likely to attract business of a particular kind until proof has been afforded that facilities of the requisite nature are already in existence. As we have previously pointed out, American firms make a point of furnishing the fullest possible details of their manufactures so that the specifications of engineers may be, as far as possible, based upon standard productions. When, in addition, it is known that any contracts placed will be executed under the supervision of experts and by the aid of plant of the most approved type, there is every reason why the American methods should be generally accepted.

The Pencoyd Works, near Philadelphia, are perhaps as well known in this country as any other, because it was there that the much discussed Atbara bridge was built. At these works no less than 170,000 tons of steel, the product of 11 open-hearth furnaces, are used yearly. Included in the plant is a comparatively new invention, the Wellman tilting furnace, capable of holding 70 tons of steel, arranged in such a manner that the whole furnace can be partly rotated, when the charge of molten steel can be poured out at one operation. The Wellman - Seaver Electric Charging machine is employed in conjunction with the furnaces; and throughout the melting-house, the rolling mill and the erecting shops, full advantage is taken of the most modern labour saving appliances. The works are planned on the progressive system, which we all know is the correct arrangement, although it is not so generally adopted in our own country as it ought to be.

A feature of American practice considered worthy of special note by *The Times* correspondent is followed in the rolling-mill at the Pencoyd Works. In changing rolls, the whole machine, including rolls and housings, is removed by an overhead travelling crane and so the rolls can be changed and work resumed in an hour and a half. The crane used for this operation is electrically driven and is naturally a very expensive apparatus. In the roughing mill, hinged hydraulic tables are fitted between the presses, and the horizontal movements are performed by electrical power so that no manual labour is required. These are merely isolated examples showing the importance attached by American manufacturers to the economisation of time and labour, and the apparently lavish manner in which they provide machinery for the attainment of this object. In the stock-yard, between the rolling mill and the bridge shop, there are various admirable mechanical appliances for saving time. Every part of the yard is commanded by an electric crane, whilst electrically driven "live" rollers are provided on which beams may be readily transported from one point to another, as passengers are carried on the *platforme-mobile* in the Paris Exhibition. The erecting shop, where the separate parts of bridges are built up to form finished structures, is a building of one floor 460 feet long by 200 feet wide, having a roof consisting of massive trusses extending from side to side and supported by a longitudinal row of eight columns. Besides serving the purpose of covering the shop, the roof is practically a gantry supporting the ways for overhead electric cranes and lifts, which move transversely and longitudinally so as to serve every part of the floor. These cranes and lifts are of various types, ranging from one-ton hoists to sixty-ton travellers. One

remarkable appliance in the erecting shop is a multiple punching machine, by William Sellers, of Philadelphia, making ten holes at one stroke, and the principal feature of the machine is that the spacing may be varied up to eight inches simply by moving an index. It will readily be understood to how great an extent work may be facilitated by the employment of such a tool, especially when holes of variable pitch have to be punched. Another perforating appliance consists of three lattice-work gantries, arranged to traverse the shop on floor-rails. A latticed girder on the top carries an electric motor actuating eight radial-arm drilling machines. Between the uprights of the apparatus four deep girders placed side by side may be simultaneously drilled. Rivetting operations are expedited by the employment of a 100-ton hydraulic rivetter, through which the material is carried by means of a travelling gantry actuated by electric power. Pneumatic tools are largely used, and most of the machine tools are electrically driven, some by separate motors and others by one motor common to a group. Altogether there are no less than 200 motors on the Pencoyd works. Two gantries extend from the storage yard over the lines of the Pennsylvania and of the Pennsylvania and Reading Railways, and the loading of materials is expedited by the use of two 40-ton electric travelling cranes, each of 60 feet span. The foregoing fragmentary notes as to the equipment of the Pencoyd Works may enable the reader to understand, in some measure, why the Atbara Bridge could be built by an American firm within a space of time considered by British engineers to constitute an insuperable obstacle.

In all bridge works in the United States, the plant is admirably planned and is invariably of the most modern description. Every possible care and attention is devoted to the checking of measurements and calculations, so that work need not be erected before leaving the yard. The members are so accurately prepared that when brought together on the site, no difficulty is experienced in fitting them in their proper places.

Speaking generally on the question of structural iron and steel-work, we think Great Britain has much to learn from the United States. Our smaller works are inadequately equipped, and our larger works, which are better furnished with machinery, are still lacking in many essentials, and notably in the technical organisation and mercantile enterprise which are such factors in the success attained by the constructional engineers of the United States.

The Latest Chinese Puzzle.

THE sinister events which have occurred during the past two months in China, have naturally been followed with the keenest anxiety by all those who are interested in the vast commerce of that country, and it is not surprising, therefore, that business men should be much exercised over the ultimate *dénouement* of the terrible drama being enacted there. For the moment considerations of trade sink into comparative insignificance before the awful tale of carnage and barbarity which has reached us. But when all is over, and the full penalty has been exacted for the crimes committed, these considerations will once again force themselves to the front and demand the thoughtful attention of all who desire to see commercial relations with China resumed and extended.

Trade has already suffered to an alarming extent. The business done with the northern ports of China has been entirely dislocated. It would be rash to indulge in any prophecy regarding the probable termination of the existing state of chaos in Pe-chihli, or to venture upon a date when the

pacification of the country will be effected. It was thought by a large number that with the divisions which were apparent amongst various sections of the Chinese, united action on their part against the foreigner would have been next to impossible. Divided as they were at one time into separate camps, one of which from motives of self-interest might have favoured the foreigner, the suppression of the Boxer rebellion and the quelling of the anti-foreign rising generally would not, it was argued, be so formidable a matter as was at first anticipated.

Since that estimate of the situation was formed we have seen that the rebellion has assumed enormous proportions; that it has been connived at and fostered by the Empress-Dowager and her satellites in the Imperial Palace; and that it will require all the strength and resourcefulness of the combined Powers to cope with it in anything like an adequate manner.

It should not be forgotten, however, that there is a large class outside the militant Chinese who regard with dismay the hostilities now taking place, and who will do their utmost to restore order. This is the trading community of China, amongst whom may be numbered some of the country's most intelligent citizens, always keenly alive to their interests and appreciating the importance of peace as the best servitor of those interests. They already recognise the immense advantages following in the train of commercial intercourse with other countries. They have learned by their own individual experience that China's future depends upon her industrial progress. They have seen that the Chinese who have been wise enough to step down from their pedestal of exclusiveness, and mix with the throng in the markets of the world have become prosperous and influential, and the districts in which they reside have been benefited thereby. No better evidence of this can be found than in the constantly increasing proportion of Chinese oversea trade which is being passed from the hands of the foreigner into those of the Chinese merchants. The great mistake which some people make at the present moment is to regard the whole Chinese race as being animated by a desire to hurl the foreigner and all his ways into the sea. The best part of the four hundred millions of people who inhabit the eighteen provinces of China proper probably do not know even now that so serious a disturbance has taken place in the metropolitan province. We live in times of exaggeration, due largely to the exigencies of a press which must print something, and the more sensational the better for a public which has grown hypersensitive and neurotic in regard to the contents of the daily newspapers. Without in anyway desiring to minimise the seriousness of the situation in the Far East, and the character of the work which has to be accomplished by the Allied Forces in order to pacify the country, we think the gravity of the situation may be unduly magnified.

And when peace is restored, what then? "There's the rub." Many people, not given to indulge in hysterical prognostications, see in the ultimate settlement by the European Concert of the conditions of things which will ensue on the termination of hostilities a far greater danger than the "Yellow Peril" itself. The discussion of the claims for compensation for services rendered is certain to give rise to vast divergence of opinion, both with regard to the amount of the compensation and the form which it shall take. It will require all the discretion and restraint of which civilised nations are capable to prevent this ultimate solution from becoming impracticable to diplomacy. Fortunately the diplomacy of the United States has already been the means of exacting promises from the combined nations which no incident in the present trouble can revoke. They are all converts and pledged to the

"open door" policy. That conversion has been attested by the signatures of responsible Ministers, and any attempt at backsliding from the new faith will be held to be an offence against the whole adherents, and will be resented accordingly. This agreement may therefore be justly regarded as a safeguard against differences of opinion amongst the allies degenerating into a scramble for territorial gains. The greatest source of danger lies in the mutual jealousy of Russia and Japan as to their respective spheres of influence in the North of China. And in this connection there is much to be said for Japan. At the conclusion of the China-Japanese war in 1894-5 she was despoiled by Russia, Germany, and France of the just fruits of her victories, and suffered the humiliation of seeing the chief of them appropriated by the former Power. If Japan had been permitted at that time to occupy the Lao-Tung Peninsula we might have been saved the horrors of the last two months, inasmuch as she would have been able to have crushed the "Boxer" rising in its incipient stages. No surprise should therefore be felt at Japan's hesitancy to pour her troops into China last month. But being there again on the common business of all the Powers it will be marvellous indeed should she submit a second time to the cavalier treatment experienced five years ago. The real crux of the future settlement lies in the adjustment of the conflicting ambitions of Russia and Japan, and this will probably prove the *pons asinorum* of the *post bellum* difficulty.

If no international complication arises, the present trouble, sad and tragic as it has been in many respects, will not be without its influence for good. It will show China that she cannot with impunity flout the rest of the civilised world. It will teach her that she must observe treaties solemnly entered into, and that she cannot be permitted to set them at nought or evade them by a succession of mean subterfuges. And, further, it will compel the Chinese Government to exercise greater vigilance in the stamping out of anti-foreign agitations, and in protecting the lives of the foreigners whom she has permitted to enter her country for the purpose of developing its enormous resources. It will bring her into line with all the nations who flourish by mutual intercourse and exchange of products. In addition to covenants which will be demanded to secure these ends, the Powers will no doubt insist upon a thorough revision of the inland taxation on foreign trade, which would involve the abolition once and for all of the objectionable "likin" dues. These "likin" duties, it may be explained, are imposts levied at the barriers of every city and correspond in some degree with the octroi duties of certain European countries. They are supposed to be leviable upon all goods, whether of home or foreign origin, which have become Chinese by actual possession of Chinese subjects. But British goods are secured by treaty rights against "likin" on payment of customs under the proper conventional tariff and certain fixed transit dues which are certified by transit passes. But the ingenuity of the Chinese mandarin raises all manner of hair-splitting distinctions as to when foreign goods become Chinese goods and vice versâ, for the purpose and with the general result of bringing everything under the "likin" yoke. The consequence is that enormous quantities of merchandise really protected by treaty stipulations are mulcted in double duties *en route* to their destination. It is a vast engine of corruption throughout the empire. No reforms, however drastic, will be of much avail in China until the collection of the internal revenues of the country is performed upon a different system to that which obtains at present. The old sources of revenue are continually sinking under the blight of provincial misgovernment. The leak-

age caused by the hopeless corruption of the mandarin increases day by day, and the necessities of the State must before long impress upon the Government the absolute necessity of placing the internal revenues upon the same basis as that which under Sir Robert Hart has wrought such miracles in the collection of customs.

The Electric Tramways and Railways Exhibition.

At last London is awakening—we mean official, administrative London—for the "man in the street" has no time to sleep, and has to keep his weather eye open in the arduous struggle for existence—awakening and realising that the world moves. You may execrate, condemn, imprison even, the men who interfere with the comfortable, self-satisfied slumber and dreams in which you deceive yourself that there is no room for improvement in your little world, that a climax has been reached, that nothing new can be good; you may even force the pioneer of progress to acquiesce, harassed by the constant obstacles you place in his way, and make him recant. When you least expect it, however, his conscience will awaken, and he will rise once more and exclaim, loud enough for all to hear, "*E pur si muove.*" Yes, "and still it moves," this world of ours; nor can any official Government, however important in their own eyes, make the world stand still. And what is more, our Governments will have to follow in this onward march of mundane affairs, be it sooner or later, unless they wish to be overthrown and left behind to bewail the blindness that made them resist what cannot be resisted. Thus it happens that the Progressive Party in London's local government, called "progressive" on the principle of *lucus a non lucendo*, has been compelled after all to yield to progress, in the person of its trusted leader, who, by a kind of poetical justice, was selected to welcome the *enfant terrible*, "electric traction," which not so very long ago he repudiated as an illegitimate intruder. His speech at the Agricultural Hall, Islington, on the occasion of the opening of the Tramways and Light Railways Exhibition, showed that he had finally made up his mind to acknowledge that electrical traction had "come to stay," and that he was ready to open his arms paternally to the newcomer, and even to pose as his real friend and protector. He can hardly be astonished that the humour of the situation was realised at least by some of his hearers; but, after all, let us remember that "it is never too late to mend," and give Mr. Dickinson credit for his welcome "change of heart." Still, comprehensive as his acknowledgment of the new state of things was, and ready as Mr. Dickinson seemed to be to give credit to whom credit is due, his insight into the real causes of the birth of electric traction plants in England seemed rather circumscribed, for there appeared to be in his memory the name of one of the British firms only which have devoted their energy to the subject of electric traction. Far be it from us to deny the merits of the firm "named" by the Chairman of the London County Council, a firm that, like many others, readily availed itself of the special knowledge and experience of our American cousins in this branch of industry for establishing an up-to-date plant on British soil, but special distinction, we think, in a gathering where many competing interests are presented is always more or less invidious. As may be seen from our descriptive article there were a great number of British undertakings represented and also a few foreign houses. The public in general, however, seemed somewhat mystified and was often unable to draw the dividing line between foreign and home manufacture. Thus, the

British Westinghouse Company, which has invested millions in our country, and, as the merest tyro could not help seeing, most prominently figured amongst the exhibitors in the Tramways and Light Railways Exhibition, was oddly enough taken by some to be an American concern. Practically all its machinery in this country, however, is designed by British engineers, and constructed in Great Britain by British workmen, while the enormous outlay of capital of this company will eventually benefit the British public. It would be just as reasonable to accuse the manufacturers of voltaic batteries of representing Italian industries, or the makers of safety-matches of being Swedish concerns, as it is to say that the British Westinghouse Company, because its products embody improvements in electric traction originally invented in America, is an American concern. Once that the entire work of a company is done on British soil, by British skill and British industry, it becomes British in the fullest sense of the word.

The Tramways and Light Railways Exhibition, which has been the first large display of electric traction plant and accessories in this country, cannot have failed to make a deep impression upon all who saw it, and has inaugurated, let us hope, a new era of progress in our country as far as urban and suburban locomotion is concerned, for we can hardly imagine that, after this demonstration of what really can be done in the field of electric traction, anybody will venture to throw serious obstacles in the way of its adoption. Our provincial friends have been ahead of us in availing themselves of electric locomotion, and deserve full credit for this, but, considering London's enormous resources, there can be no doubt that the metropolis will soon occupy, even as regards this feature of progress, the place which is legitimately due to its importance.

Great Britain at the Paris International Exposition.

It is truly strange that however great the space of time allotted to contractors and exhibitors may be, the opening days of nearly all great exhibitions find everything in a state of ill-disguised chaos, and weeks, nay months, elapse before the various displays are in working order. This has been demonstrated once more in connection with the Paris Exposition where, even at this late date, some displays are still in an unfinished condition. Early visitors to the Paris Exposition have seen little more than a group of buildings in their nascent condition, while the exhibits were hardly unpacked as yet, though there were a few notable exceptions. The exhibits of Great Britain did, unfortunately, not belong to the latter class. As we are informed, by a reliable Commissioner whom we engaged to give an impartial report on the subject, there existed even at a very recent date quite a chaotic condition in the sections allotted to British enterprise, and many of the exhibitors are yet deprived of the power required to drive their machinery. How much of this state of affairs is due to the indifference or intentional neglect of their French hosts is a question which we prefer to leave unanswered. For a great portion, however, of the unsatisfactory state of the British exhibit the exhibitors themselves must be blamed, since their phlegmatic nature and self-satisfied indolence did not permit them to rise to the occasion as some of their continental and, still more so, their trans-Atlantic competitors have done who got their show into order in spite of the obstacles placed in their way. But even after having got their displays into shape, the British exhibitors still remain at a disadvantage in Paris because of the lack of linguistic attainments on the part of their representatives, and their foolish assumption that

intending customers will go to the trouble of getting the English catalogues offered to them—and offered moreover, it seems, not very liberally—translated. Other exhibitors distribute freely descriptions of their goods in the language of foreign buyers, and most of them are represented by men who speak two or three languages besides their own. All this, however, has been so frequently repeated by our consuls and commercial agents abroad in their reports to the Foreign Office, that we hardly need enlarge on the subject.

As is usually the case, our American cousins have shown resource and adaptability in dealing with unexpected difficulties arising in connection with the great Fair. Finding that the space allotted to them in the Exhibition grounds would hamper them in making a display of the working of their machinery they have captured a large area at the Vincennes annexe, running, it is true, the risk of fewer visitors—for this annexe is a few miles away from the main show—but fully determined to make the journey to their machinery exhibition worth while. And they have succeeded, for all who went out of their way to see the American mechanical side-show agree that it is attractive and instructive, and well worth the time necessary to see it and the slight discomfort incurred by the railway journey.

Comparing the character of the British exhibits with that of the foreign displays our Commissioner states that, in his opinion, the comparison at once shows why a great deal of our trade has, of late, gone to foreign markets; for it is evident that while manufacturers of other nations have accommodated themselves to modern requirements and abandoned old-fashioned types of manufacture, our own makers have been content to repeat themselves and to reproduce patterns that have ceased to be new twenty-five years ago, acting on the famous principle that what was good enough for their fathers is good enough for them. Moreover, they will have to learn a lesson from industrial war, which our generals have learned but recently from real war, namely, the importance of knowing how the land lies before offering battle. Germans, Americans, and others among our rivals, are constantly scouring the markets of the world to see what is required, and consequently are ready to meet the demands made upon them. Our own producers, when they finally make up their mind to force their way into new fields, meet with constant surprises. It is said that the chief obstacle in our way in dealing with foreign competition lies in our labour conditions. This is true to a certain extent, but to a certain extent only. Although in the United States labour unions do not possess the tyrannical power which they enjoy among ourselves, this is due not so much to different social conditions, as such, as it is to the fact that American employers, once they saw the danger that threatened them, made a firm front and defeated their antagonists by their own game, namely by a combination of employers' interests, excelling in organisation even the well-managed labour unions. This, therefore, is merely another proof of the greater adaptability of Americans to given conditions and there, in fact, lies the key to the whole situation. If we wish to regain our industrial supremacy, which to a certain extent—fortunately to a very small extent only—we have lost, we must make up our mind to be abreast of the times. Once we do so, we must succeed, for as regards wealth, conditions of existence and perseverance, there is no nation equal to our own. All we need is to decide at once upon what is necessary, and having realised this necessity and decided to meet it, our very stubbornness, so much in our way at present, will be our surest guarantee of success.

"We are, in the vastness of our possessions, losing our grip on national sentiment. It is our duty to maintain intact, and to defend by sea and land, all that our empire builders have left us. The day that sees the defence of the British Empire sapped, sees the disintegration of the Nation's trade and the hands of civilization's timepiece put back 200 years."—RT. HON. LORD CHARLES BERESFORD, C.B.

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British Municipal Supporters of Foreign Competition . . .

WE are truly at a loss in what language to place before our readers an act so unpatriotic on the part of the local authorities of a British municipality, that we should refuse absolutely to believe it to have been committed had we not before us in black and white the fullest proof in the form of a document signed by the Borough Engineer of Southend-on-Sea. That the ratepayers of that town can be aware of the way in which their municipal officers are spending the rates is not creditable, and we feel convinced that the truth will be a shock to them as great as it must be to every patriotic Englishman. At this very moment, when the technical, as well as the political, press of our country unanimously endeavours to stir up our manufacturers to make a firm stand against foreign competition, and in this very hour of earnest effort to rally British producers, the Corporation of Southend-on-Sea throws into the lap of our American competitors the funds which have been entrusted to it by the community which it has the honour of representing.

Southend-on-Sea is in want, it seems, of certain truck and car equipment for an electric trolley line, and only a few weeks ago visitors to the Agricultural Hall in London had an opportunity of seeing that such material is obtainable in our country, at reasonable prices, from industrial concerns that are exclusively British, and which spend the money they receive in our own country, employing British brain and muscle and encouraging British manufactures. What more natural, therefore, than to offer to such firms an opportunity of competing for the supply of the material required by the above-named Corporation? This is so obvious that the local authorities of Southend-on-Sea realised that, by the merest rules of decency, they were obliged to ask these firms for tenders. It is one of our best known engineering firms whom we have to thank for handing over to us the document that was sent to them. On page 1 of the specifications, where the Corporation describes what motors are wanted, we read as follows: "The equipment under this section *must* consist of the following apparatus and materials, inclusive of supply, delivery and fixing. Each car to be supplied with—Two *Thomson-Houston* G.E. 52 Railway

Motors on 10 double-deck cars ; two *Thomson-Houston* G.E. 58 Railway Motors on two bogey cars ; two *Thomson-Houston* G.E. 800 Railway Motors on two single-deck cars," &c. Why any British firm, excepting the British Thomson-Houston Company, should be invited to furnish the above-named motors is an absolute mystery, for the choice of Thomson-Houston manufactures in preference to others has obviously been made beforehand, and naturally these manufactures cannot be supplied cheaper by anybody else than the Thomson-Houston Company. Since, however, there is a *British* Thomson-Houston Company in existence, our readers will perhaps say that the selection, although it indicates favouritism, is at least not necessarily unpatriotic. Granted, so far ; but let them read what follows on page 2 : "The motors shall be of the *General Electric of America's* manufacture." Here, then, we see that not the *British* Thomson-Houston Company is intended, but it is stated in so many words that no "British" makers need apply, not even such as are called British by courtesy, and that the goods *must* be of *American* manufacture. Again on page 3, for instance, we find, with reference to "Controllers," that these also "are to be of the series parallel type of the *General Electric of U.S.A.*" On page 5, with regard to "Trucks," occurs the following stipulation : "The twelve four-wheeled trucks shall be of *Brill* (21 E. type, with solid forged frame) or *Peckham extension manufacture*," i.e., American, and "the four bogie trucks are to be *Brill*, or *Peckham Maximum Traction Trucks*," while "the *axles* are to be of open-hearth steel of *Pennsylvania Railroad* standard, quality, and test." On the next page, finally, we read that "four bogie *Brill*, or *Peckham maximum* trucks are to be provided for," and so on throughout the whole document. To make *American* manufacture, in a British municipal enterprise, a *conditio sine quâ non*, and to deprive British manufacturers of even a chance of competing, is an act on the part of the local authorities of Southend-on-Sea that the patriotic ratepayers of that town—and we trust that these form a vast majority—should chastise as a gross abuse of their confidence ; but to send to British firms a copy of a document of this nature, under the pretext of inviting tenders, is an action that, in the name of these firms, we feel it our duty to stigmatise as a disgrace for all those responsible for it. We most earnestly hope that never again shall we have occasion to bring to public notice a breach of loyalty to British interests so flagrant as that committed by the Corporation of Southend-on-Sea.

Manchester Dock Extension . . .

A GREAT scheme of dock extension has been prepared in connection with the Manchester Ship Canal. No fewer than 142 acres of land will be added to the dock estate, comprising 99¼ acres at present occupied by the Racecourse Company ; 40 acres purchased from Col. Clowes, and 2¾ acres acquired from the Corporation of Salford. Upon this area two dock basins, each half a mile long, will ultimately be constructed, parallel with the existing Salford basins. The new basins will therefore increase the present quay frontage by two miles, and will provide berths for 32 additional vessels of 330 feet in length. At the present time the total extent of quay accommodation is about 5½ miles, but a considerable proportion of this is above Trafford Bridge, and therefore not available for large steamers. Consequently the proposed additions will nearly double the capacity of the docks for ocean traffic. The Manchester Ship Canal Company has not at present asked for powers to con-

struct more than one of the proposed docks, and even this will not be at first excavated to the full length. Moreover, in virtue of a clause in the new Act, the racecourse is not to be disturbed before December, 1901, without consent. It is, therefore, possible that the commencement of active operations may be deferred for nearly eighteen months, and as it is estimated the construction of the new works will occupy four or five years, the additional accommodation will come none too soon. A great part of the new site will be devoted to railway sidings for the sorting and marshalling of wagons employed in transporting cargo from one part of the dock to another, and also for the exchange of traffic between the Canal Company and the various railway companies. As illustrating the growing importance of the canal, we may mention the fact that the Lancashire and Yorkshire Railway Company has expressed the wish that some twelve acres of land shall be devoted to the formation of balloon sidings for Lancashire and Yorkshire traffic at the docks.

Those who have followed the returns know how greatly traffic has increased on the Ship Canal. Spare land has gradually been absorbed, spaces allotted to open-air cargoes have been covered by transit sheds for general cargoes brought by huge vessels from Canada and the United States, and last summer even the railway sidings were covered with timber stacks. Since the appropriation of the Liverpool timber docks for the use of the regular Atlantic liners, there has been a gradual transference of the timber trade to Manchester, and this circumstance alone is sufficient justification for the works now proposed.

The timber and kindred trades will in time be removed to more commodious docks, where ample quay space and open storage ground will be provided ; the existing docks will then be available for the general cargo and cotton trades, and the dock railway system will be extended, so that the rapidly increasing volume of traffic may be dealt with in an adequate manner.

State Purchase of Railways . . .

CONSEQUENT upon the increased cost of labour and fuel, the railway companies have exhibited a very natural disposition to raise the rates for transport, as in Scotland, and to enforce charges for wagon hire, demurrage, weighing, and other items which have been more or less overlooked in the past. Traders do not appear to be particularly pleased at alterations of this kind, and deny the right of the companies to advance their rates. In view of the hostile attitude in which the mercantile community and the railways stand towards one another, and of the probability that further friction is likely to take place in the future, it is worth considering whether the question of the purchase of the British railway system by the State ought not to be revived.

At a recent meeting of the British Iron Trade Association, Sir A. Hickman exprsesed the opinion that a good deal of the advantage which the Americans have over English traders is due to the cheap railway rates in America. In that country rates are decreasing concurrently with the present increase in Great Britain, and as greater competition in every branch of industry may now be expected from the United States, it is extremely undesirable that any conditions should exist which are prejudicial to the proper development of our own manufactures. With the exception of lines south of the Thames, most of our railways are excellently controlled, though there is necessarily a vast amount of money and energy wasted in competitive advertising and duplicate services. These drawbacks could be abolished if each line formed a unit in one general organisation ; but, on the other hand, the public entertains a most wholesome distrust of Govern-

ment methods, and if the railways of the kingdom were controlled by a department constituted on the model of the War Office it is not clear that much advantage would result.

Railway servants, from the general manager to the humble porter, only retain their appointments so long as they are found to be discharging their several duties in a satisfactory manner. This condition applies in a very limited degree to civil servants, each of whom is in a sense independent of his seniors, and cannot be dismissed save for dishonesty. Again, the laws of promotion recognise age and length of service rather than ability, and no one could expect railways to be properly administered on lines such as these. When the question of purchase comes to be discussed in a practical manner, we hope the trading community will not lose sight of this essential consideration.

Canadian Steel Plates . . .

"ONE of these fine days you will see Canadian steel plates coming up the Clyde, and underselling the Scotch article in the home market." Thus spoke a gentleman the other day in the course of a conversation anent the British iron and steel trade, and certain experimental consignments of steel plates to the Clyde, not from Canada, but from the United States. He was a man well posted in all concerning iron and steel manufacture and with an intimate knowledge of the Transatlantic trade. Without desiring to raise any unnecessary note of alarm, we venture to point out that there are solid reasons for not disregarding the prophecy. There are developments in steel manufacture taking place in Canada, with the help of capital from the United States, which, in the near future, may become even unpleasantly familiar to British manufacturers. Mining and indeed every other industry on the Atlantic side of Canada has ever failed to attract the British capitalist. It is in the West that English gold has been lavished. Cape Breton, Prince Edward's Island, New Brunswick and Quebec have been foolishly neglected by the British investor. At last the American has arrived in Cape Breton and has characteristically "gone the whole hog." A syndicate has spent, or is in course of spending, no less than twenty-five millions of dollars—five millions of pounds sterling—in the establishment of a smelting and steel-making plant, which will probably be second to none in the world. The spot selected for this gigantic enterprise is so near the sea shore that ocean-going vessels can come alongside a wharf, a mere stone's throw from the mine, and on to which the works actually abut. Now this port, situated within two or three days' steaming of the principal manufacturing centres on the Atlantic seaboard of the United States and within six days of the Clyde, has an ideal position for trade with both East and West. The anticipation, therefore, of the British steel market being controlled by the Canadian product, is not altogether such a wild notion as it at first sight appears. The moral, if there is a moral, seems to be this, that British steel manufacturers can by no means afford to rest on their oars or neglect any practicable means of improving their methods and cheapening their product.

Oil Separation from Exhaust Steam . . .

IT is interesting to note that the difficulty hitherto prevailing in overcoming the matter of oil separation from exhaust steam has been accomplished. The Klein Engineering Co., Ltd., have recently introduced an oil separator which efficiently takes all the oil from the steam and at this same time upholds the vacuum without in any way withdrawing the steam, which hitherto has meant a loss of 3″ or 4″ of vacuum. The system of Central Station Condensing Plants, with which the name of Mr. Klein is associated, is coming to the front, a large plant to work in connection with iron fan-driven coolers being the latest installation.

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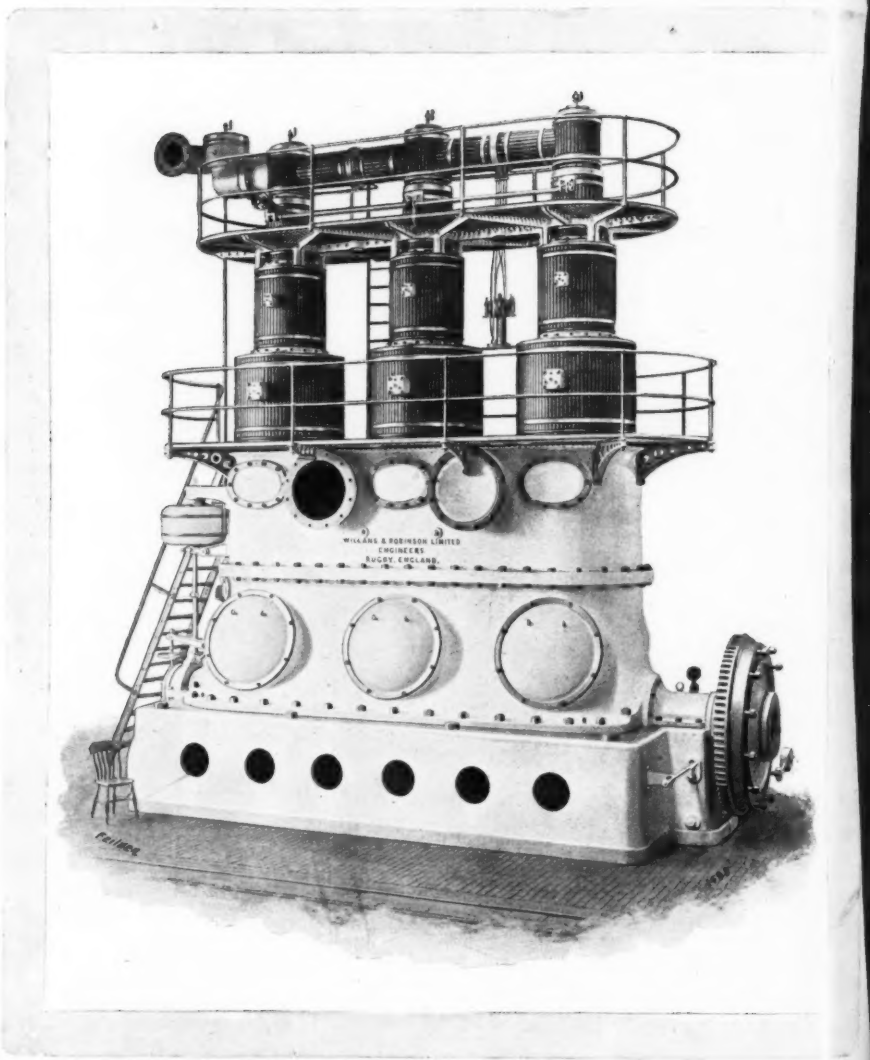
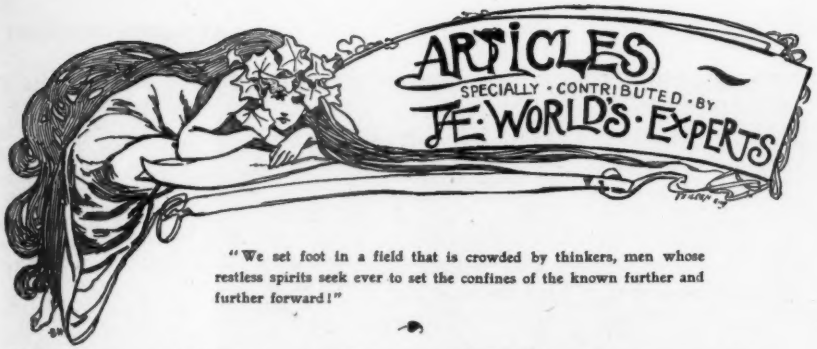


2,500 H.P. WILLANS CENTRAL VALVE TRIPLE EXPANSION ENGINE AT THE PARIS EXHIBITION, DRIVING A SIEMENS MULTIPOLAR DYNAMO. SPEED 200 REVOLUTIONS PER MINUTE.

By MESSRS. WILLANS & ROBINSON, LTD., RUGBY, ENGLAND.



"We set foot in a field that is crowded by thinkers, men whose restless spirits seek ever to set the confines of the known further and further forward!"

Modern Stoneworking Machinery.

By M. POWIS BALE, M.I.MECH.E., A.M.I.C.E.

MR. M. POWIS BALE, who is a Member of the Institute of Mechanical Engineers and an Associate Member of the Institute of Civil Engineers, was educated privately and at King's College School, London. He was subsequently articled to Messrs. Powis, James and Co., Victoria Works, Lambeth, one of the pioneers of wood-working machinery, and was with them twelve years.

Some twenty-five years ago Mr. Powis Bale commenced business on his own account. He has of late years made a speciality of wood and stone-working machines for special purposes. He has carried out many large contracts, including several for Her Majesty's Government, and introduced stone-working machinery into South Africa.

Mr. Powis Bale is the author of a number of books on sawmill engineering, economical steam-engine management, etc., which have gone into numerous editions, while he has contributed to all the leading technical journals.

In addition to his manufacturing and contracting business, Mr. Powis Bale has a considerable practice as a consulting engineer, valuer, and expert. In steam and general engineering he is an arbitrator to the London Chamber of Commerce, and has been appointed arbitrator directly by the Law Courts in several important cases.

ALTHOUGH the obelisks, monoliths, colossi and remains of temples, &c., of ancient Egypt, Italy, Greece and India conclusively prove that the art of quarrying and working of stone was well understood thousands of years ago, the introduction of machinery of an advanced type for this purpose is quite of modern origin.

Some 35 years ago, Sir Fothergill Cooke and Hunter designed a superior series of machines which were constructed by the firm of Powis, James and Co., and set to work in London, but the general progress of this class of machinery has been slow till within the last ten or twelve years, when, owing to higher wages, shorter hours, and generally increased competition amongst contractors and builders, considerable impetus was latterly given to this important branch of engineering.

As the object of the present paper is to give—as far as limits of space will

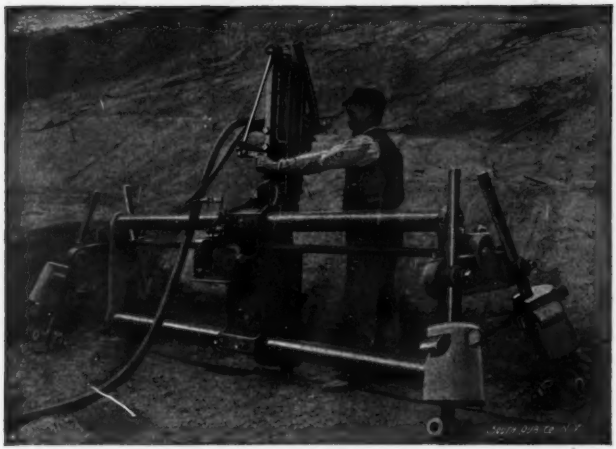


FIG. 1.—BAR CHANNELLING MACHINE.

permit—what may be termed a bird's-eye view of the present position of the industry in this country, it may be as well to briefly summarise what machinery can now do in this connection.

Stone may be quarried, sawn, dressed, faced, moulded, turned and polished. Architrave mouldings, cornices, ovolos, pilasters, astragals, ogees, scotias, strings, and other straight, undercut and curved mouldings may be shaped and finished in every way superior to, and at an immense saving over, hand-labour. All the heavy work in small mouldings, panels, recesses, &c., can also be worked. Hard flagstones may be dressed ; landings, copings, steps, channelling, &c., may be tooled, granite turned and polished, and many other operations may be performed too numerous to recapitulate here.*

Although much has been done during recent years as regards the introduction of machinery for working stone, it need hardly be said that ample scope still remains for inventors in this direction.

* See "Stoneworking Machinery," by M. Powis Bale.

QUARRYING MACHINERY.

Although large numbers of quarries are still worked in a primitive fashion by means of hand-jumpers, drills, &c., considerable progress has been made of late by the introduction of power-driven rock drills, bar channelling machines, steam track channelling machines, and, to a limited extent, by steel rope quarrying machines. The action of the ordinary rock drill is probably sufficiently well known, but a large variety of drills of different types and combinations, to suit varying circumstances, are now made. Within the limits of our space, however, it is impossible to give them more than a passing notice. We think the general consensus of opinion is in favour of a drill which strikes the stone directly and with an uncushioned blow, the shock being taken direct by the piston. The drill should be rotated automatically, but unless the stone is even in its consistency and its nature well known, many operators prefer feeding by hand to automatic feeding, as it can be readily eased should circumstances dictate. Compressed air, steam, and electricity are the powers generally employed for driving. A considerable difference of opinion exists as to the advisability of attempting expansion of air or steam used for driving in rock drills, it being contended by those in favour of non-expansion that the *raison d'être* of the rock drill is to get the hardest possible blow on the stone from the smallest sized steam cylinder, and that any gain from expansion is counter-

balanced by the necessity of employing —where expansion is used—a larger sized cylinder to get the same hardness of blow and consequent amount of work done. Supposing the cylinders of an expansion and non-expansion drill to be of the same diameter, the first would use steam or air, but not striking so hard a blow, would have to make more strokes to do the same amount of work ; and when the increased size, weight, cost, and lessened portability of the expansion drill—as at present made—is borne in mind, the saving, to say the least, is very problematical. For quarrying purposes,where portability, combined with rapid work, is a feature, the writer is in favour of non-expansion drills. The stroke of the piston should be readily variable to suit the nature of the work, and for working granite and other hard stones drills constructed with an auxiliary valve, in addition to the main valve, have latterly come considerably into use. The drills are mounted on different types of adjustable tripods, bars, gadders, &c., and it is important that these are carefully selected to suit the nature of the work.

Compressed air and steam are generally used for driving. Various attempts have, however, been made to introduce electricity for the purpose, but for quarrying, at any rate, it has as yet made comparatively little headway. This is owing, probably, to the intermittent character of the work, the increased initial outlay and heavier weight of drills, and the necessity of employing more highly skilled labour. We, however, anticipate further improvements and developments in this connection.

Where a number of drills are employed and the power has to be carried a considerable distance, compressed air is undoubtedly to be preferred to steam, as it can be delivered to the drills a long distance in a dry and elastic condition, whilst the necessary loss of steam from condensation would be very great and the consequent work of the drills reduced in proportion. Where a few drills only are used and the boiler can be placed near them, steam may be employed with advantage, the initial outlay for plant being thus largely reduced. When compressed air has to be conveyed to a distance—especially when the weather is cold—a considerable economy can be effected by heating it before using in the drills. This can be readily done by means of a heater fed with coal, coke, gas, oil or other fuel, the air being passed through it on its way to the drill. The cost of this arrangement is small, and, as the expansion of the air thus treated is very considerable, a distinct gain is effected over using the air cold. The heater should be placed near the drills, the pipes carefully covered, and all elbows be of as wide a radius as possible, as the loss of energy from the friction of the

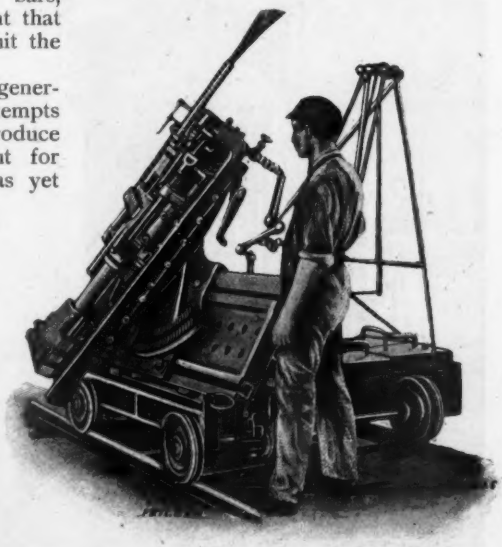


FIG. 2.—SCREW CHANNELLING MACHINE.

air in the pipes is great. To keep this down it is generally concluded that the velocity of the air in the pipes should not exceed about 2,500 feet per minute.

For working cranes, sawing, planing machines, &c., in quarries, electric power has been introduced to a limited extent, and we look for a considerable expansion in this connection, more particularly in isolated spots or where adequate water power is available.

Fig. 1 represents an Ingersoll-Sergeant bar channeller, which is an adaptation of their ordinary steam rock drill. It is a powerful machine, mounted on double bars and traversed forward and backwards on them automatically by means of a screw bar and gearing, actuated by a small three-cylinder engine. This arrangement is clearly to be seen in the illustration, and is very effective. The process of channelling is to first drill a round hole at each end of the intended cut with the drill, using an ordinary drill bit, then to release the rotation gear of the drill, replace the drill bit with a gang of channelling chisels, and let the machine run, channelling deeper and deeper as it travels back and forth. The channel is 3 inches wide, and can be up to 7 feet deep by 8 feet long, and if required longer; the machine is shifted to the next position by pinch bars inserted under the lugs at the bottom of the legs. This machine is used for slate, marble, limestone and sandstone, and in sandstone of moderate hardness it is claimed that 110 to 115 sup. feet can be channelled in 10 hours. It can be adjusted for channelling at any angle from vertical to horizontal.

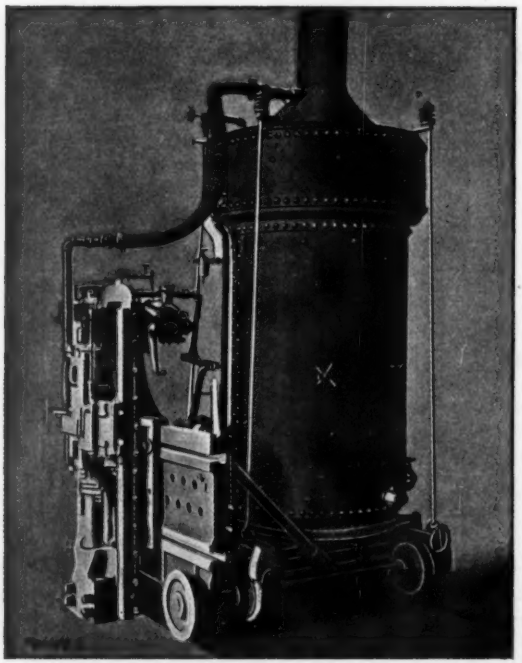


FIG. 3.—STONE CHANNELLING MACHINE.

Fig. 2 represents another form of the channelling machine last described. It is adapted for angular or vertical cutting in marble or other quarries, where the floor is to be enlarged, or for putting in head cuts, tunnelling, cutting out corners, &c. It is light in weight and readily moved about. It is fixed on the trolley, without a boiler, and being actuated either by steam or compressed air, conveyed through wrought iron pipes with flexible joints, can be used where ashes, smoke, or cinders are objectionable. This machine cuts channels vertically or at an angle of 45 degrees. Another modification of this machine is made which will cut channels horizontally.

A modification of the rock drill is shown by the Ingersoll-Sergeant track channeller, Fig. 3, and is an

arrangement of a powerful percussive machine operating a gang of channelling chisels, mounted complete with a boiler, on a bedplate provided with track wheels, and running on a light portable rail track over the space required to be channelled. The machine has a variable stroke, adapting it to inequalities in the texture of the rock, and striking a hard and quick blow or a light and rapid one, and is of the single gauge type, the chisels having a solid abutment in a steel clamp. It is of the simplest construction, with direct strains, ensuring that the least amount of power is lost in transmission.

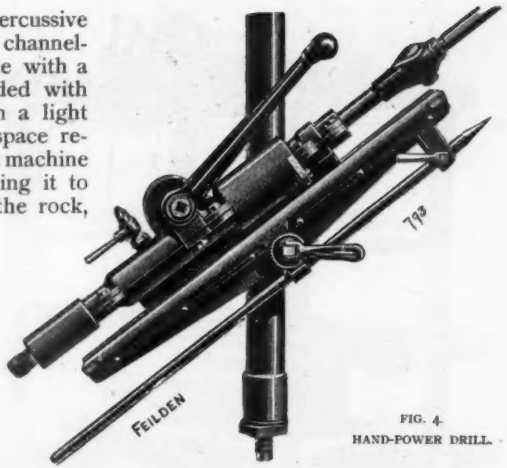


FIG. 4.
HAND-POWER DRILL.

In ordinary freestone, after the track is laid ready for work, it is claimed that from 40 to 60 superficial feet per hour can be channelled by this machine.

In small quarries where power is not available a good deal may be done by means of a hand-power percussive drill.

We illustrate in Fig. 4 the Jones hand-power drill made by the Hardy Patent Pick Co., Ltd. This drill is worked by means of a cranked handle, which operates a spring-propelled hammer. The spring is coiled, and is adjustable to any desired force of blow from 60 to 300 lbs. Two blows are made by the drill for every revolution of the crank, and are brought about by the alternate compression and release of the coiled spring. This is done through the medium of a mutilated cog-wheel working into a rack cut in the hammer itself. It strikes a non-cushioned blow, and the recoil of the drill is utilised to operate an automatic feed. The rotary motion of the drill is also automatic, and completes a full circle in every eleven and a half strokes. It is usually mounted on a tripod column or quarry bar, and can be operated in any desired position.

In France and Belgium quarrying by means of a running helicoidal wire rope is practised. This rope is usually made of three corded strands of steel, which when running acquires a twisting motion, and being fed with sand and water, abraids or cuts its way into the stone. After the cuts are made into the stone it is usually forced from its bed by means of screw-jacks. The wire-rope system of quarrying has not yet been introduced into this country, but, given suitable lying beds of stone, this method should be capable of effecting a large economy over those generally pursued.

HORIZONTAL STONE-SAWING MACHINES.

After the stone leaves the quarry it usually passes to the horizontal, or, if not too hard, to the circular saw, for conversion into slabs, blocks, &c.

In the construction of horizontal saw frames, the main frame should, by preference, be made of iron of ample section ; girders are suitable if properly stayed, and increased stability is given by extending the foundation plates of the main uprights, and allowing the stone truck and the stone being sawn to rest on them. The swing or saw frame, connecting rods and moving parts should be of steel, combining as

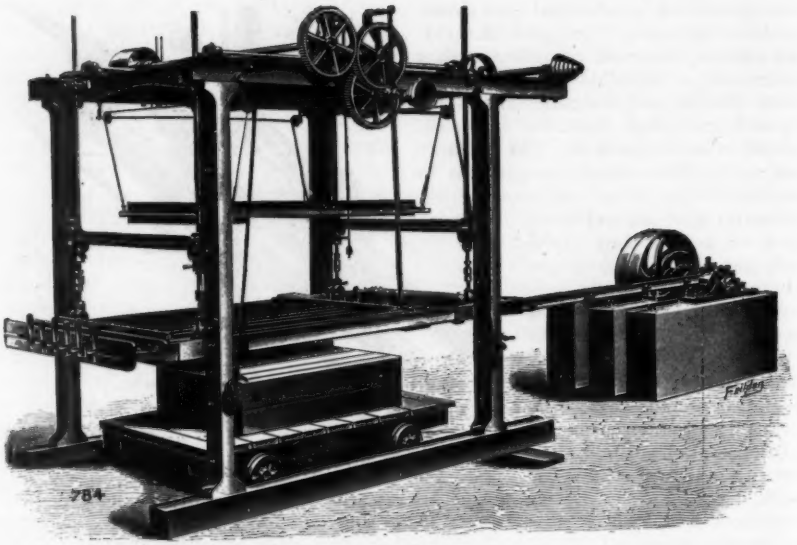


FIG. 5.—HORIZONTAL STONE SAWING MACHINE.

far as may be strength with lightness. Cast iron is sometimes used for the swing frame, but is unsuitable, as in addition to its extra weight, it may be broken by the immense tension to which it is subject when a number of blades are cottered up together. An important factor in efficient working is the method by which the blades are fed into the stone, so as to give a uniform pressure throughout the cut and to avoid jump. For this purpose the writer recommends an automatic downward screw feed, which he has found to hold the blades well and firmly to their work.

The swing frame is usually driven by a crank or a pendulum movement, but with large frames an engine is sometimes coupled direct. The crank is to be preferred, although the pendulum is sometimes used in cramped situations.

When driven by crank the connecting rods should be long, and the writer prefers a pair of rods to a single one, and if these are arranged to take hold either at the back or the middle of the swing frame, and carefully balanced, vibration is reduced to a minimum. As these machines cut by abrasion, to secure rapid and effective work it is important that the cutting blades are fed with a constant and even supply of sand, chilled steel particles, or other cutting agent, and water. This is usually secured by mounting a sand box the full length of the block of stone, and giving it, by cam or other means, a slow rocking motion across the face of the stone.

The cutting blades are usually plain blades of soft steel, but some have been recently introduced with vertical corrugations, and it is claimed for this arrangement that the cutting agent is more rapidly carried down to the edge of the blade, and its cutting or abrasive power is increased. Although chilled steel particles cut faster than sand, in sawing marble and ornamental stone it is important that they be

washed away at once, as if allowed to adhere to the surface of the stone for some hours they are found to stain it; consequently, many marble workers still continue to use sand.

For cross-cutting long blocks of stone, marble, &c., a modified form of rip saw frame is used. This is usually arranged to carry from one to three cutting blades, and run at a considerably higher rate of speed. In this case the stone is arranged to enter the machine from the side and not the end, as in the ordinary machine carrying a number of blades. For driving either form of frame, a bent crank can be recommended. This should run in three long angle pedestals bolted to the foundation plates. It is important also that all joints of the swing frame should be accurately planed to fit each other and be fitted with adjustable plates to guide the motion of the frame, together with gauge brackets and rods, and gauge pieces planed to standard sizes. The screws for downward feed should be of steel, and all working parts be made adjustable for wear.

Fig. 5 illustrates Rushworth's Patent Horizontal Stone, Marble and Granite Cutting Machine driven by a belt. The connecting rods and swing frame carrying the cutting blades are built of steel, and the main frame is of massive construction enabling the machine to be run at a high rate of speed. It is fitted with a positive downward screw feed and an arrangement of taper and speed cones through which the speed of cutting can be readily regulated to suit the nature of the stone without stopping the machine. It is also fitted with a quick return motion for rapidly raising or lowering the swing frame and blades to any desired position. The countershaft consists of a forged sweep crank shaft running in diagonal pedestals.

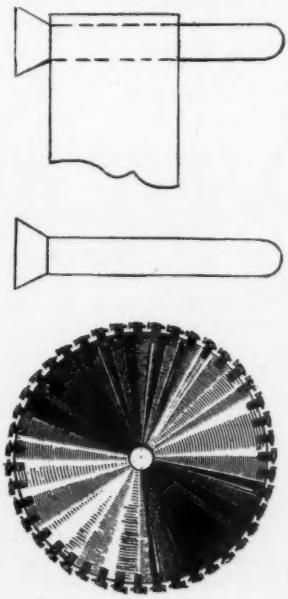
These frames are also constructed to work by means of a direct acting engine, and are speeded to cut at from 3 in. to 30 in. depth per hour according to the hardness of the stone.

After the stone has been converted by means of horizontal or circular saws and it is required to be reduced to a dead-true surface, it is passed on to the rubbing bed or table, or if dressed or moulded to the planing or moulding machines.

RUBBING BEDS.

These consist briefly of a large disc of hard cast-iron, sometimes as much as 13 ft. diameter, mounted on a vertical shaft and made to revolve at a considerable speed by means of a crown wheel and suitable gearing. The blocks of stone are placed on the table and rubbed to a true surface by means of sand or fine steel particles, and water. In lieu of the ordinary type of machines which require a pit and expensive foundations, the writer can recommend them to be built self-contained, the only foundation then required being a bed of concrete.

The frame of the machine should be of massive construction and the bed be



FIGS. 6, 7 AND 8.

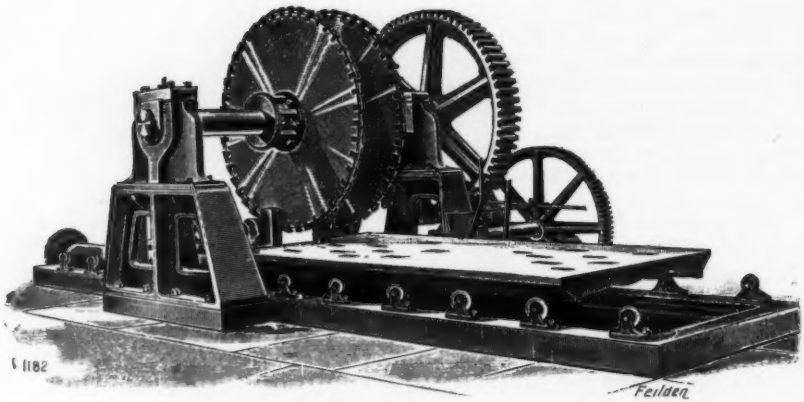


FIG. 9.—CIRCULAR STONE-SAWING MACHINE.

supported by friction rollers to reduce the pressure on the vertical shaft footstep bearing, which often gives considerable trouble. With heavy beds, instead of an ordinary footstep bearing the author has introduced an arrangement in which the base of the vertical spindle —which is extended and turned flat on the surface—is made to rotate on a series of ball bearings enclosed in an oil chambered pedestal. The pressure per square inch is thus largely reduced, and if kept free from dust and properly lubricated this bearing will run for a long time without requiring repairs.

For rubbing small and light slabs a rotary disc machine is often employed. This consists briefly of a disc mounted on the end of a long vertical pendulum spindle with double universal joints, which is made to rotate, the stone being placed on a truck beneath it, and the disc fed with steel particles or sand, and water.

CIRCULAR SAWING MACHINES FOR STONE.

Circular saws with steel cutting tools are not adapted for converting hard stones, but for Portland, Bath, and the ordinary stones used in building. They are found much more rapid than the horizontal machines just described, and for ripping, facing and edging have come considerably into use. Circular saws take more power to drive and waste more stone than horizontal saws, but their output is considerably greater, being under ordinary conditions from 150 to 250 running feet per day of ten hours.

As the working pressure on the saw teeth is considerable, in constructing a machine it is important that the saw spindle bearings be of ample area and supported by heavy side standards, and the whole machine be of massive construction to overcome the working vibration.

Circular sawing machines are generally designed somewhat after the fashion of a planing machine for iron, but instead of the ordinary tool-box and slide, a saw spindle driven by powerful toothed gearing is mounted and the stone to be sawn is fixed on a travelling table which passes immediately beneath the saw. For traversing the table, either a screw or a worm and rack feed, is steadier, and to be preferred to a rack and pinion feed. For squaring up and edging, two saws may be mounted on the same spindle, the stone being firmly held and guided laterally to prevent springing when

taking a thin cut. In large contracts where a very fine joint is not necessary this method will be found very expeditious and to effect a large saving over hand labour. The saws can be depended on to cut to the lines marked out, which is a great advantage over all splitting methods. The most important factor in the successful working of circular saws for stone is found in the construction of the teeth and much ingenuity has been exercised in this connection. What is required is a tooth at once simple in form, cheap, and one that can be readily made or repaired by an ordinary smith.

After a lengthened experience the writer has not found a tooth that answers these conditions so well as that illustrated by Figs. 6, 7, 8. Fig. 6 shows the tooth out of its socket or holder, and it consists briefly of a bolt or nail made from the best rod steel and forged with a trumpet or cup shaped head which is turned at the edge and afterwards hardened. Fig. 7 shows this tooth mounted in its socket or holder and Fig. 8 the "false" teeth mounted round the periphery of a disc of steel. As one cutting edge becomes worn from the grinding action of the stone the tooth can be slipped round in its socket so as to present a fresh cutting margin, and after the head is worn down it can be softened and set up again by the blacksmith.

As regards the speed of the teeth no arbitrary rule can be laid down as this will depend on the nature of the stone. A speed, however, of 25 ft. to 30 ft. per minute will usually be found suitable with a feed speed of the stone of from 3 to 9 in. run per minute.

Fig. 9 shows a circular sawing machine adapted for rapidly converting large blocks of stone, designed by Mr. George Anderson. As will be seen from the illustration, it is of very massive construction to withstand the considerable strains to which it is subject. One, two, three, or four saws are mounted as may be required. For thick sawing two are generally used, but for thin sawing three or four. It is fitted with a screw-feed and quick return motion, and the handles for the different motions are placed together and are readily under the control of the operator. This machine can also be adapted for facing blocks by mounting—in lieu of, or in addition to the saw—a cast-iron disc fitted on its one side near the periphery, with a series of the trumpet headed tools already described.

DIAMOND CIRCULAR SAWING MACHINES FOR STONE.

Machines in which diamonds are used as the cutting tools have been

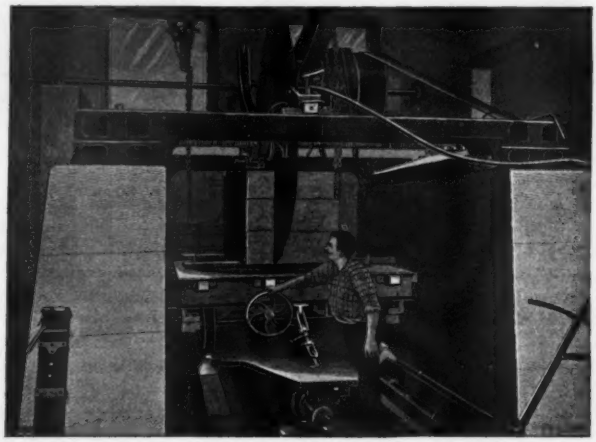


FIG. 10.—DIAMOND CIRCULAR SAW FOR STONE.

introduced to a limited extent. Instead of running at a slow rate of speed as is necessarily the case when steel is used as the cutting medium, these saws are made to revolve at a high velocity, *i.e.*, some two miles per minute at the periphery. Small Cape or Brazilian diamonds—which are mounted in sockets at the periphery of the saw plate—are usually employed, and there

The diamonds used are usually of hexahedron or truncated prismatic form, and in addition to securely fixing them in the periphery of the saw care must be taken they are so arranged that they cut a proper clearance for the blade to pass through the stone or it may become jammed and buckled. The blade itself should be rigid when running at full speed and

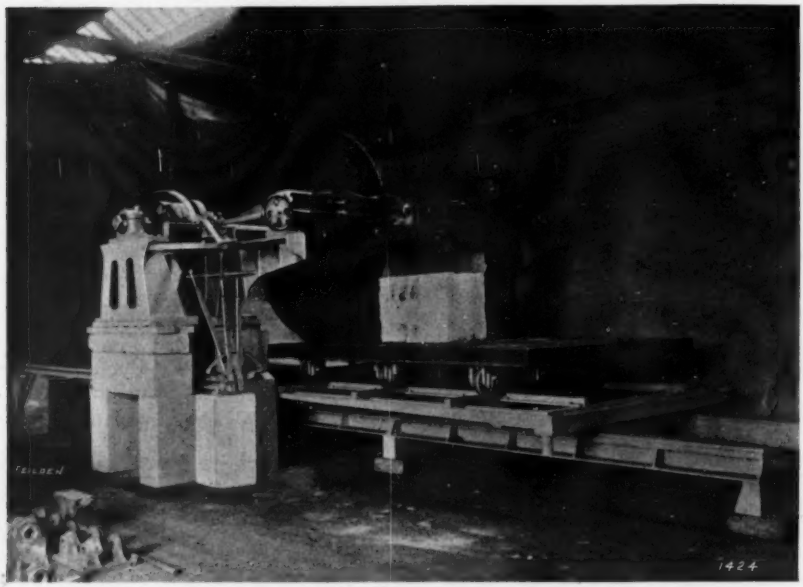


FIG. 11.—DIAMOND CIRCULAR SAW FOR STONE.

is no doubt they turn out a very large amount of excellent work, but they possess the disadvantage of being liable to be dragged from their seatings, and special means are taken for their recovery. Cutting stones by means of diamonds is not a new idea, but hitherto most of the machines introduced have had a short life, so the conclusion to be drawn is—looking at it on the principal of the "survival of the fittest"—that they have not been hitherto commercially successful.

good cast steel should be used in its construction, as it is found that common or mild steel when running at a high speed is apt to become wavy and pliant.

A number of patents with the object of holding the diamonds securely in their seats have been taken out, including fingers clamped in sockets, imbedding the diamond in the saw with solder or holding it in clamps kept in position by wedges, &c., but all of these plans have proved commercial failures. In one machine the diamonds

are held in the ends of split screw bolts or clamps, which are tapered and forced into tapering holes, causing them to contract on the diamond.

Various systems of caulking, embedding the diamond in copper, hot iron, &c., have also been tried with unsatisfactory results. A plan for mounting diamonds that has met with some success on the Continent is to heat the sockets to a bright red heat and force the diamonds into their seats by pressure, the subsequent contraction of the metal being relied on to hold them in their places. Reciprocating diamond saws have also been tried hitherto with an unsatisfactory result, as it is found that the reciprocating motion rapidly loosens the sockets and drags them from their seats. Should this difficulty be overcome there should be a great feature for this type of machine.

Endless band saws set with diamonds are used in France to a limited extent, the machine invented by M. Seboyer being the best known. As the ordinary band saw blade running over two wheels would be of much too thin a gauge to fix the diamonds on its cutting edge, the inventor employs a much thicker saw, viz., about 4 millimetres thick, composed of sheets of steel rivetted together, and instead of running the saw in the usual way with the flat side of the blade bearing on the saw pulleys, he runs it edgeways on, and supports it on each side by means of grooved rollers.

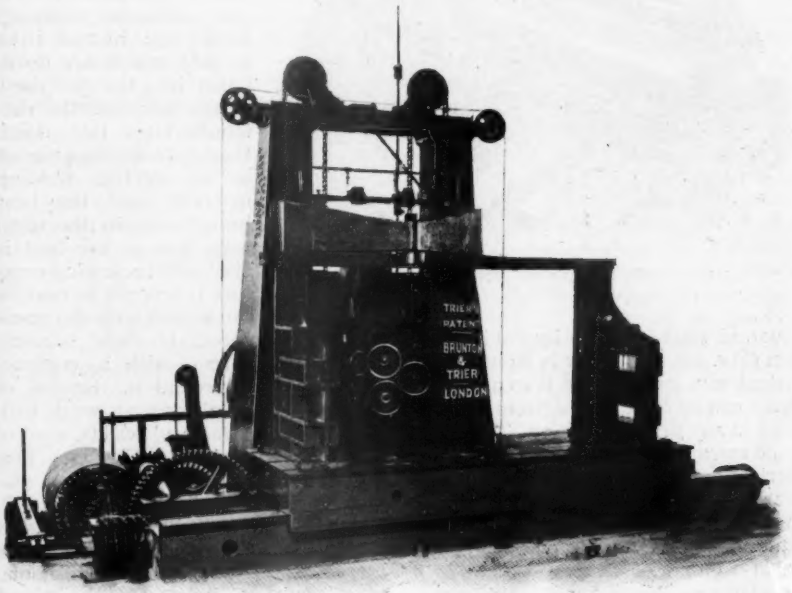


FIG. 12.—HARD STONE-DRESSING MACHINE IN OPERATION AT THE PARIS EXHIBITION.

This is certainly a very ingenious arrangement and given the satisfactory holding of the diamonds in their seats, this machine should prove itself of great value, more particularly for curved work, such as that required in Gothic windows, arches, &c.

One method of working circular

FIG. 13.—STONE DRESSING AND MOULDING MACHINE.

diamond saws is shewn by the illustration (Fig. 10). The saw is mounted on a steel saw spindle, and is so arranged that it can be traversed horizontally and fixed in any desired position. The stone to be sawn is mounted on a travelling carriage and is automatically fed through the saw at speeds varying according to the nature of the stone, but with soft building stones it is claimed a speed equal to that of sawing wood on a circular saw bench can be attained. There is very little concussion when the diamonds strike the stone, and they appear to practically scratch their way through it. This machine is of French origin, and is, we believe, constructed by Messrs. D'Espine, Achard et Cie. Although up to the present it has had but a comparatively limited trial in this country, we shall look for further developments of this system with interest. The illustration is taken from a photograph of a machine that has been at work some time on the new General Post Office contract, Liverpool, and has, we believe, been employed chiefly in cutting Portland stone.

With the object of securely fixing the diamonds in their seats, what the writer considers will prove itself a most valuable invention, has recently been made and patented by Mr. George Anderson of Carnoustie. The principle adopted is that of electric welding. Holes are bored into sockets which are dovetailed into the periphery of the saw, and the diamonds fitted into them. Each socket is then placed in an electric welding machine, and the heat brought up in the usual way, and as the heat is gradually increasing pressure is brought to bear on the socket, with the result that the diamond is thus securely sealed in its seat with a compact mass of metal around it. Several of these saws are already at work with extremely satisfactory results, one of which is illustrated by Fig. 11. This machine carries a saw 7 ft. 4 in. diameter, and will take in a stone 12 ft. long by 7 ft. wide by 3 ft. thick. It is fitted with a compound table for carrying the stone, so that whilst one block of stone is being sawn the second table can be loaded so that the saw can be kept almost constantly employed and a considerable amount of time saved. The machine generally is of massive construction, and is fitted with automatic reversing motion and a graduated feed. The saw whilst running can be traversed from one end of the spindle to the other by means of screws fitted in the cross-rails which carry a sliding bracket or platen, to which are attached the saw-guides and two ½ in. water pipes, one on each side of the saw, to keep it cool and wash out the sediment from the cut.

The diamonds are "staggered" or placed zig-zag in the sockets to give a fair division of work to each diamond and cut a clearance for the blade. A blade $\frac{1}{4}$ in. thick with the diamonds in good working order cuts a groove fully $\frac{3}{8}$ in. wide, but part of this must be attributed to the vibration of the blade itself. We are informed this machine is cutting a fairly hard stone at the rate of 6 in. run per minute, and hard Peterhead granite at $\frac{3}{4}$ in. per minute, a much higher speed than can be attained by any other system.

STONE DRESSING AND PLANING MACHINES.

Machines for dressing or planing stone may be roughly divided into three classes—(1) machines in which the cutters have a rolling action; (2) machines in which the cutters act with a dead pressure; (3) machines in which the cutters are fixtures but the tool-holder revolves.

Class 1, in which the cutters have a rolling action as distinct from a dead pressure, are very efficient machines for most classes of stone, but are particularly adapted for hard stones, which are naturally usually much more difficult to dress than the general run of building stones. Machines for working hard stones are often made somewhat after the fashion of a planing machine for iron, the stone being placed on a table with a horizontal traverse, which is worked to and fro beneath the cutters by powerful worm gearing actuating a worm rack placed beneath the table. A duplex system of revolving cutters is generally employed; these are mounted in compound slides above and at the side of the stone, so that its two adjacent surfaces can be worked at the same time. The cutters are of steel, and circular in shape, somewhat after the fashion of a saucer, and have a rolling motion when in action; consequently the great friction arising from a dead pressure is done away with, and the cutters having what may be termed a "rolling wedge action" split or roll off the inequalities found on the surface of the stone. Some stones may be finished at one operation, but in others roughing and finishing cuts are necessary. By arranging a series of cutters "step cuts" may be taken if desired,

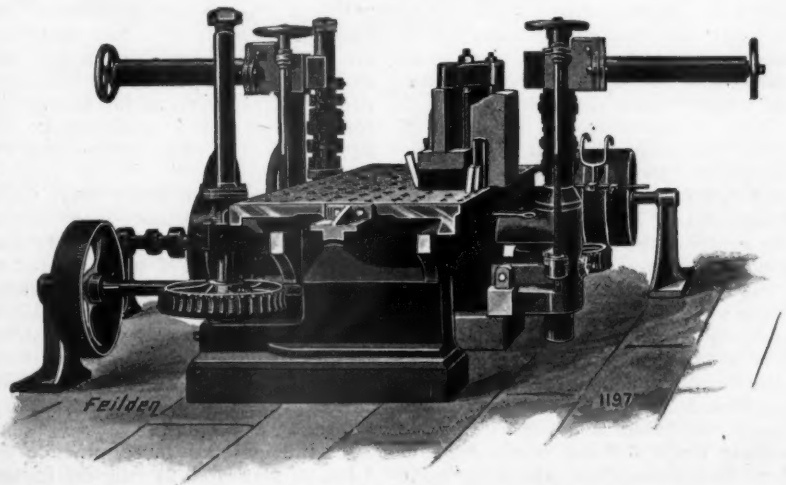


FIG. 14.—DUPLEX STONE MOULDING AND PLANING MACHINE.

and it is found in practice that with a nicely adjusted rolling action there is very little attrition, consequently little heat is produced and the cutter edge wears away very slowly, which is not the case with tools which operate with a dead pressure on the stone.

This system of rolling cutters was patented some years ago by Messrs. Brunton and Trier, and the pith of the invention may be said to consist in giving to circular cutters a determinate rotation on their own axis, at the same time that they are carried round in a circle, their cutting edges describing a circular path, and the rates of cutter rotation and movements round the circle, being so adjusted relatively one to the other, that the cutting edge rolls exactly in the circular path or track. The inventors claim as novel the use of a circular rotating cutter, operating by rolling and chipping off from the stone the inequalities of its surface. This, they say, constitutes the elementary principle, and may be stated as a rolling pressure brought to bear at the base of a certain projecting portion of stone, with the intent to force it off. The great power of such a pressure to effect the desired object is due to the fact that its incidence at any given moment extends over a very small space, and that upon this small space the whole force is concentrated.

Fig. 12 illustrates the latest type of stone dressing machine from the designs of Messrs. Brunton & Trier, now being shown in operation at the Exhibition in Paris. In this machine the guides of the main standard contain a slide—carrying several rolling cutters—which is moved up and down by a crank action. The stone is fixed on the table by means of cramps and screws (not shown) carried by the brackets at either end and a shaft in the bed carrying three worms which gear with a rack under the table and impart variable cutting feeds and fast return feeds in both directions. The side of the stone to be dressed is allowed to overhang the edge of the table and the cutters which move up and down, split off the irregularities of the advancing stone, and it is claimed by the makers that they produce a perfect surface with straight tool marks superior to hand-tooling. The two sets of cutters are inclined opposite ways, so that the stones can be surfaced from either end, and they are set to cut on different levels, the roughing cutters being followed by a finishing cutter, thus enabling finished surfaces to be produced at one operation.

The rates of travel of the stone past the cutters vary with its nature, from about 2 in. per minute for granite, to 6 in. for grit or sandstone. To reduce as much as possible the time occupied in fixing the stones, duplicate sets of tables running on wheels and rails are employed.

Referring to class No. 2, stone planing machines in which the cutting tools act with a dead pressure on the stone. These are usually built after the fashion of a planing machine for iron but with different kinds and arrangements of tool boxes and cutting tools. They act well with many classes of stones, but with others—as the pressure of the tools on the stone is a dead one—they are found to "stun" or "pluck" the stone and give broken arrises. To overcome this, however, as far as may be, some makers now fit a motion for relieving the tools when approaching the end of the cut.

It is very important that these machines be of massive construction throughout to overcome the very considerable vibration of working, and by preference, the bed plate should be cast in one piece. In the older machines, the traversing table carrying the stone, worked in V's driven by a rack feed, but as the table was apt to jump after a heavy cut, this gave place to dovetail slides.

In the most advanced practice, the table is arranged to run on friction rollers, and is actuated by a worm or

screw feed. When these machines are used for moulding and planing copings, sills, mullions, steps and similar classes of work, the main table is fitted with a supplementary rocking table by which means a stone may be planed or moulded on three sides without removal. The dressing tools are forged from bars of steel, sharpened at the points, and in advanced machines mounted in tool boxes arranged to turn over automatically after every traverse of the table, and present a fresh cutting edge to the stone, they consequently require little sharpening, and operate on the stone during both the forward and backward journeys of the table. The turning over of the tool-holder for reversing the position of the cutting tools is made automatic in conjunction with, and actuated by, the reversing motion of the travelling table carrying the stone.

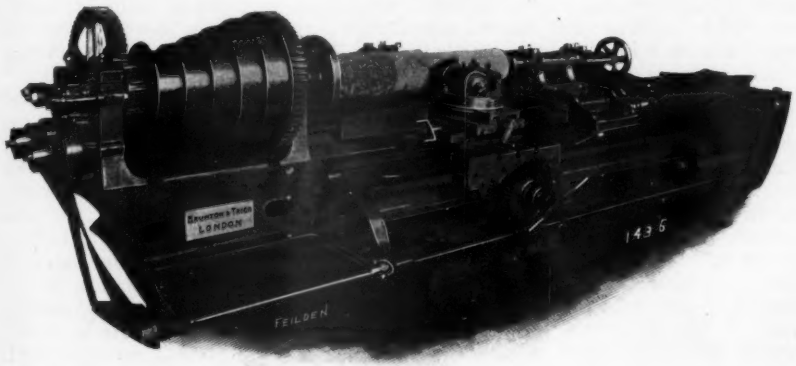


FIG. 15.—STONE TURNING LATHE.

For "scabbling" heavy blocks of stone for rough dock, &c. work, or before passing it to the saws, a somewhat similiar machine to that described, but with a series of tools extending to the whole width of the stone, and mounted in horizontal and vertical crossheads, is usually employed.

Fig. 13 represents a patent stone dressing and moulding machine by Messrs. Coulter and Co., the general features of which will be readily understood from the illustration. The tools are mounted in a tool box sliding on the crosshead, and can be readily adjusted to any desired position on the face of the stone by means of a hand wheel and quick threaded screw, and the crosshead itself, rapidly raised or lowered either by hand or power. The table is plated in the roller grooves with steel plates, and fitted with a powerful vice to hold the stone firmly when under the action of the cutters. Adjustable stop-brackets are fitted alongside the table to regulate the traverse according to the length of stone being worked, also an automatic arrangement for turning over the tools, and presenting a fresh cutting edge after each traverse of the table. To prevent the stone "plucking," a relieving motion is applied which relieves the tools when nearing the end of the cut.

The whole machine is of massive construction, and the working details appear to have been well thought out.

STONE MOULDING MACHINES.

Of the various machines specially used for moulding stone, the writer prefers the principle of Hunter's Patent

Duplex Machine, illustrated by Fig. 14.

In this machine the stone is subjected to the action of both revolving and scraping tools. The mouldings are roughed out by the small trumpet headed steel cutters, similar to those used for circular sawing, and shown by Fig. 6. These are mounted horizontally in flat malleable iron tool holders, which are arranged in rotation on duplex vertical spindles (one placed on either side of a travelling table, upon which the stone to be worked is fixed), the sizes of the tool holders being graduated according to the depth of the various members of the moulding. The cutter spindles are driven by worm gearing, the two worms being inside, right and left handed, the thrust of each partly counteracts that of the other. The travelling table is driven by means of a screw or a worm working into a rack fixed on the underside of the table ; this worm is made to slightly taper on a shaft somewhat inclined, so that the outer end of the shaft, to which is applied reversing bevel gear, is sufficiently low to permit the table to travel over it. After the moulding is roughed out, it is finished to the exact profile of a template by means of flat profile steel cutters, which are used as scrapers ; these are fixed in tool holders, mounted on vertical columns with elevating screws. On the upper part of these columns are fixed cross tubes, in which the tool holders are worked, and advanced or retired as may be necessary. One tool on either side of the table roughs out as it travels one way, and the others when it travels the reverse way, so that no time is lost in running the table back for a fresh cut, as in other machines of this class. A simple and efficient plan for holding the roughing out tools has been adopted. It consists of a malleable casting, having holes for the reception of the tools, and transverse steel keys fitted on inclined beds. The tool being inserted into the hole, is fixed securely therein by drawing up the key by means of a nut. The key is formed with a V edge, which slightly impresses itself into the tool, and prevents it from moving. Two or more tools can be fixed in one holder. These tool holders are for some kinds of stone mounted in trunnions, thus presenting a fresh cutting edge to the stone when the spindle is reversed.

For moulding and surfacing curved work, a revolving table can be employed with advantage ; in this case the cutters are usually stationary, the table carrying the stone being arranged to revolve against them. For holding shafts or pillars in position whilst being moulded or planed, the author has employed a modified form of headstock ; these can be moved about on the table, and made adjustable to blocks of varying length. For "checking" deep mouldings, a circular saw may be used with advantage ; this is fixed on the top of the cutter holder, and cuts into the stone before the tools following it come into play. For working architraves, strings, cornices, &c., in soft stone, and with fixed tools, it is important that the rate of feed and depth of cut be regulated by the nature of the stone. For edge moulding and trueing up slabs, &c., vertical spindle machines with a travelling table, arranged with two motions, one tangential to the circle described by the revolving cutter, and the other at right angles to this, are usually employed. In concluding these remarks on stone moulding machines, it may be said that those best acquainted with the subject are decidedly in favour of using a combination of revolving cutters for roughing out, and stationary scraping cutters for finishing, in preference to two stationary sets of cutters ; the dead contact of the roughing cutters with the stone being less, consequently the wear and tear, and power required to drive is reduced in proportion, and there is less liability to "pluck" the stone.

STONE TURNING LATHES.

Lathes for turning granite columns, marble, &c., must be of massive con-

struction, and by preference fitted with double beds, planed to receive dovetail slides, and jointed by pivots to the separate block, which carries the fast headstock. Each bed to be fitted with a strong saddle, carrying a compound slide rest with a swivelling tool holder for two circular revolving cutters. All slides should be provided with hand adjustments, and each saddle have in addition a self acting motion towards the fast-head. The bed to be carried on sole plates and so arranged that they can be set parallel to each other or be adjusted to any taper up to, say 1 in. in 4 ft. The loose headstock should have its base extended so as to rest on both beds, and be fitted with a compound parallel motion to keep the centre true with the fast headstock, when the lathe is set for taper turning.

The fast head-stock should be fitted with four speed cone, and double purchase gearing, and two traverse cones, one for the self-acting motion of each saddle.

Fig. 15 shows one of Brunton & Trier's lathes for turning columns and circular work. The lathe is massively built with double beds and slide rests so that a cutter can be brought to bear on each side of a column, thus equalizing the pressure and expediting the work. The beds are made adjustable and can be set to angle for the production of taper columns. A recent improvement consists in mounting the cutter-holders on segmental slides by which means the angle of the cutters can be altered without otherwise altering their positions thus greatly facilitating the production of circular moulded work.

In turning machines for making and trueing up grindstones, &c., the same system of revolving cutters has been very successfully introduced.

In addition to all kinds of parallel columns, tapered or swelled columns, pilasters, urns, capitals, bases, circular monuments and pedestals, and various other similar work can also be readily produced.

In addition to the machines already noticed, various forms of pneumatic hammers, drills, &c., have been recently introduced into America for marble and masonry work, and we look forward to their development with interest. The author hopes shortly to have a set at work in London, but doubtless owing to the well-known English conservatism as regards new applications, he has found it a considerable difficulty to get those chiefly concerned to take an interest in the matter.

ARRANGEMENT OF STONE WORKS.

All works, whether at the quarry or elsewhere, are best arranged on what may be termed the progressive system, *i.e.*, the heavy rough blocks of stone should come in at one end of the yard and pass directly to the saws for breaking down, and so seriatim through the other machines till finished. In large works an overhead traveller should run the full length of the yard and be so arranged that it can rapidly pick up the stone and place it on the various machines. A good plan is to arrange the machines in one line, commencing as follows: (1), horizontal saws; (2), circular saws; (3), dressing and planing machines; (4), rubbing beds; (5), moulding machines; (6), turning lathes; (7), polishing machines. A tool shop should also be provided. A tramway may run at the front end of the machines, the full length of the yard, and down on the other side of it, on which can be erected the hand mason's shed.

Railway Rolling-Stock of High Capacity.

By J. D. TWINBERROW, Assoc.M.Inst.C.E.

Mr. J. D. Twinberrow was educated at Bedford County School, where he secured many prizes and awards, including the Scholarship of the Royal Agricultural Society.

He became a pupil of Mr. T. W. Wardell in March, 1884, at the Stratford Works of the Great Eastern Railway: he subsequently followed his chief to the North Eastern Railway. Leaving the latter company in 1889, he gained experience in the design and construction of new works, in electro-metallurgy, and other specialities, filling appointments as engineer and works manager in South Wales, and latterly in the Birmingham district.

He returned to the North of England in the summer of 1897, entering into partnership with his old friend and schoolfellow Mr. G. H. Sheffield; since that date he has devoted much time to the demonstration of a long-standing as to the possibility of reducing the growing working expenses of British railways. The Council of the Institution of Civil Engineers awarded him a Miller prize for his contribution on "Flexible Wheelbases of Railway Rolling-Stock," which was printed in Vol. xcviii. of the Minutes of Proceedings. He was successful in the examination for Whitworth exhibitions in May, 1889.

The tendency to increase the capacity of the individual units is well defined in all branches of transportation, the object aimed at being the reduction of the first cost, of maintenance charges, and of the expenditure of labour per ton moved. During the last decade quite a revolution has been brought about on American railways by replacing the old 20-ton cars by vehicles capable of loading 35 to 50 tons each, concurrently with the employment of engines of greater power, to haul trains of 3,000 tons gross weight.

A similar movement was inaugurated with great success by the late Mr. E. M. G. Eddy on the New South Wales Government railways. He thus increased the gross receipts per train mile by 15·5d., of which sum only 3·5d. was absorbed by increased working expenses. Though hampered by the narrow gauge of 3 ft. 6 in., with excessive gradients and curvature, the Natal Government railways were able to reduce their rates for coal traffic to $\frac{1}{3}$ pence per ton-mile, the principal factors in reducing the working expenses being the 20-ton steel bogie wagons and eight-coupled engines of great power. European railways make some use of 20-ton cars for the export traffic in minerals, rolled steel work, &c., from the interior of Belgium, France, and Germany, whilst the four-

wheel wagons of the State lines in the latter country are frequently of 15 tons capacity.

German engineers are closely observing recent American progress, and the capacity of the stock is likely to be increased at an early date. The equipment of Russian railways will in future be largely influenced by American types, large orders for cars and locomotives having been placed in that country, whilst factories for their production at home are being equipped with American machinery. The rolling stock of the Imperial Chinese railways has been designed by Mr. C. W. Kinder in accordance with American practice, and a large proportion of it has been supplied by American firms.

The condition of the goods and mineral traffic on our home railways is now critical, as the requirements of increasing trade are not being met with sufficient promptitude. The serious congestion around Sheffield, in the Birmingham district, and in all centres of industry, renders imperative the careful study of any proposals for facilitating the working of traffic. The existing stock of wagons is inadequate, and there is no reason to anticipate their utilisation to better advantage by greater promptitude in unloading and return ; it is also evident that any addition to the numbers of the standard type of wagon will tend to increase the density of the block, whilst the construction of additional roads and sidings will be a costly matter, and will necessitate the postponement of the urgently wanted relief to a more or less distant future ; nor does the financial position of British railways warrant an unlimited annual addition to capital expenditure, for the profits on the increased business are insufficient to liquidate a proportionate share of the interest charges.

It will probably be admitted that the prosperity of American railways is in-

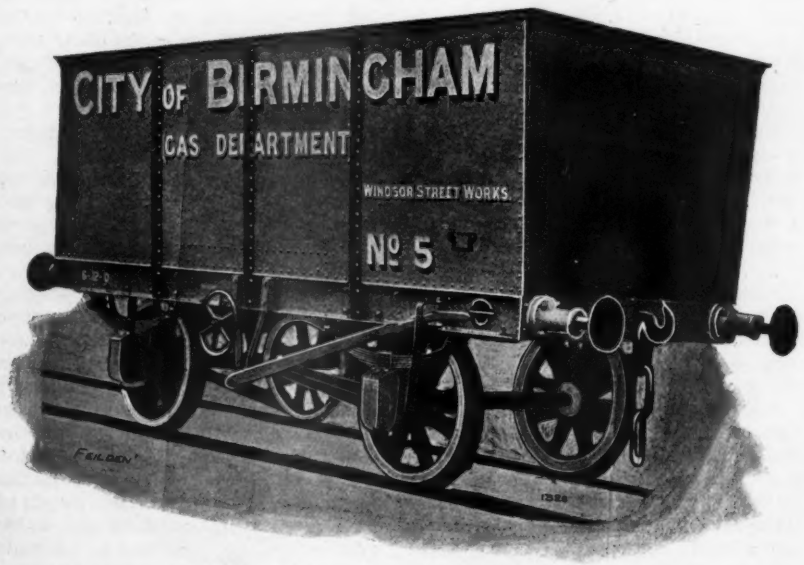


FIG. 1.—STEEL HOPPER WAGON TO CARRY 10 TONS.

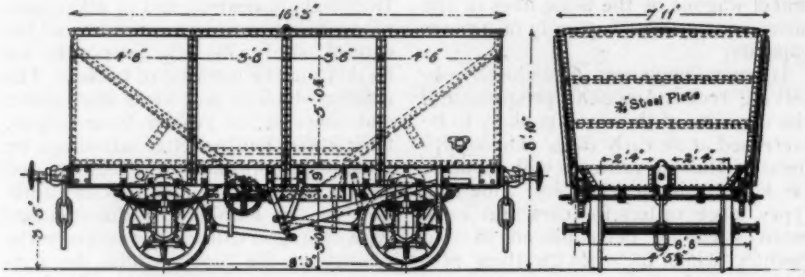


FIG. 2.—STEEL HOPPER WAGON TO CARRY 10 TONS.

creasing concurrently with the growth of business, though traffic rates are stationary or declining. As an instance of this, we find that during 1898 the Grand Trunk Railway of Canada had an increase of receipts amounting to 5·96 per cent., whilst the expenses were advanced by 4·37 per cent., and the train mileage by 1·44 per cent. On the other hand, during the same period, the railway traffic in the United Kingdom produced an increase of 3·04 per cent. in the receipts, but necessitated an addition to expenses of 5·4 per cent. and to train mileage of 3·47 per cent. British railways are coping with the increased traffic by adding more engines and cars of the same power and capacity as those already in use, whereas the Canadian line is adding to its equipment more powerful engines and cars of larger size.

It has been urged that the small British wagon must be the fittest for the needs of this country, because it has survived without radical change the usage of half a century ; but the doctrine of the survival of the fittest presupposes a struggle for existence, which in this case is absent on account of the artificial protection afforded by the regulations and standard specification of the railways ; the prescriptive right of this type of vehicle to monopolise the transportation business of the country has only recently been seriously questioned.

Railway managers have found that the average load transported by each goods wagon does not exceed 2 tons, and have thence concluded that small wagons will, on the whole, yield a more favourable ratio of actual load to tare weight ; but it is desirable to bear in mind that a considerable proportion of the general merchandize, such as timber, steel plates and sections, imported food stuffs, and the like, can usually be dealt with in large truck loads ; whilst the total tonnage of goods handled by the railways in 1898 was 110¾ million tons, the tonnage of minerals, which are always offered in full truck loads, was no less than 267¾ million tons.

Mr. C. de N. Forman has pointed out (Min. Proceedings Inst. C.E., Vol. cxxxviii, p. 385) that every penny spent per ton upon the handling and transport of our yearly movement of minerals represents over one million pounds sterling.

The principal items in the working expenses are the charges for locomotive power, for maintenance of way, for traffic and for repair of wagons ; the gross weight of each train is limited only by the power of the engine, but the gross receipts are directly proportional to the net tonnage carried. The introduction of a type of wagon which increases the net tonnage, whilst the gross weight of each train remains constant, will enable a corresponding reduction to be made in the train mileage necessitated by a

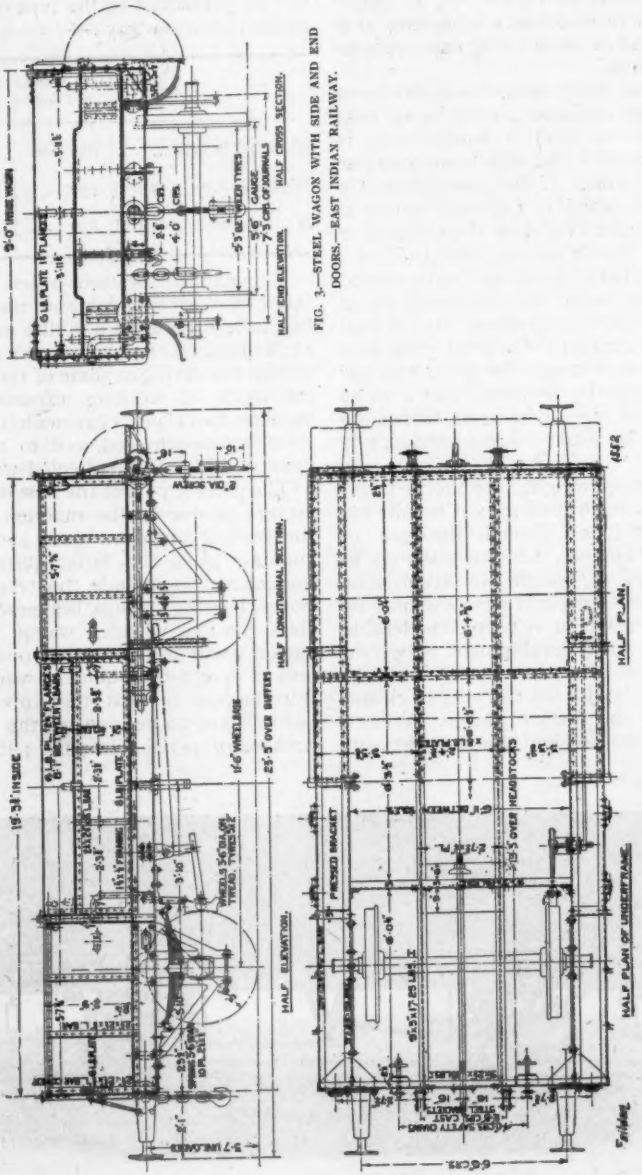


FIG. 3.—STEEL WAGON WITH SIDE AND END DOORS.—EAST INDIAN RAILWAY.

given volume of traffic; or, in other words, a proportionate economy will be effected in the working expenses per net ton mile.

The standard mineral wagons used on British railways carry 8 or 10 tons each, and the ratio of load to tare is about 1·56 to 1, the maximum load per axle is 8½ tons. If the permissible axle load were raised to 12½ tons, which is about 25 per cent. less than that of a standard goods engine, the load of a four-wheeled wagon might be increased to 17 tons, as the tare will work out at about 8 tons; the resulting ratio of load to tare is 2·2 to 1. By employing four axles for each wagon the gross load per vehicle may be doubled, and a more economical type is secured, increasing the ratio of load to tare to about 2·57 to 1.

The gross weight of mineral trains on British railways does not usually exceed 650 tons. Though the use of powerful engines, hauling loads up to 3,000 tons in weight, in accordance with recent American practice, may be shewn to result in a very considerable economy, such development is beyond the scope of the present communication, which deals with the carrying stock and not with the motive power. With a constant gross weight the gross receipts will be influenced by the type of wagon in the following way:—

Type of Wagon.	Gross Weight of Train.	Paying Load.
Standard British	650 tons	396 tons
High capacity, 4-wheel	650 „	447 „
High capacity, 8-wheel	650 „	468 „

The number of train-miles necessitated by a given volume of traffic will be in the inverse ratio of the net loads, *i.e.*, as 100 : 89 : 84·6 in the above cases; so that the saving in some of the principal items of working expenses may amount to 11 per cent. with the new type of four-wheeled, and to 15·4 per cent. with the eight-wheeled wagon.

The greater part of the cost of wagon repairs is due to the maintenance of the buffing and draw gear, and of the running gear, the latter term being understood to include the tyres, axle-boxes, bearing springs, brakes, &c., and since the four-wheeled wagon of high capacity will do the work of one 10-ton and of one 8-ton standard wagon, the introduction of that type involves a reduction of 50 per cent. in the relative number of perishable parts; the eight

FIG. 4.—STEEL WAGON TO CARRY 20 TONS.—GREAT WESTERN RAILWAY CO.

wheeled type will replace two standard 10-ton and two 8-ton wagons, and will therefore effect a reduction of 75 per cent. in the number of buffing and draw gears, and of 50 per cent. in the number of running gears.

Though the weight and cost of the individual parts will be somewhat greater in the case of the high capacity wagons, there appears to be good reason to anticipate a saving in cost of maintenance which may amount to 50 per cent. of the existing cost.

We have noted that the total tonnage of minerals moved in 1898 was 267¾ million tons, which necessitated the working of about 100 million train miles; from the average costs per train mile, as published by the Board of Trade, the total costs of four items in the expense of working this mineral traffic are ascertained :—

	Working Expenses for Mineral Traffic	Saving at	
Locomotive Power ...	£3,491,666		
Maintenance of Way ...	£2,363,500		
Traffic ...	£4,554,166		
	£10,408,332	15%	£1,561,249
Wagon repairs ...	£1,225,000	50%	£612,500
		Total saving	£2,173,749

The annual saving capitalised at 4 per cent. yields upwards of 54 million pounds, which is a measure of the expenditure justifiable in order to renew the stock of wagons, and to replace old-fashioned terminal plant, where such is an obstacle to the introduction of larger wagons.

There is, morover, a great additional advantage resulting from the compactness due to loading in larger units. Four ordinary wagons, with their buffers in contact, require a standing space of 76 ft.; one large wagon, equalling their combined capacity, will measure 43 ft. over the buffers, hence by employing stock of the latter type the holding capacity of existing sidings will be increased by 77 per cent., which indicates the immensity of the relief which would be afforded from the congestion at present existing in so many quarters.

If the reasoning upon which the foregoing estimates of the advantages of high capacity is accepted as correct, it may appear strange that home railways afford so little visible evidence of effort in that direction. There are difficulties to be overcome, possibly of a more serious nature than those which usually beset all progressive movements; and in this case the special difficulties affect several departments of the railway service, and therefore demand unity of purpose therein.

The principal physical difficulty occurs in the matter of terminals, which are frequently fitted with turntables, short traversers, lifts, &c., which cannot deal with long wagons. Some of these terminals are on private property, and are therefore beyond the control of the railways, and in many cases have no facility for shunting beyond a horse or men with pinchbars; again, some retail traders have no storage capacity and use the railway wagon as a store from which their deliveries are made; a small wagon is then necessary in order to avoid demurrage charges.

All large consumers of minerals are disposed to believe that the use of high capacity rolling stock will fully realise the estimated economies, but the principal advantage will accrue to the railways, who may possibly at some future time make corresponding reductions in their charges; but such expectation is too problematic in character to warrant expenditure on the part of traders in order to fit their terminals for the use of the stock in question. This consideration appears to threaten a dead lock upon the move-

FIG. 5.—STEEL WAGON TO CARRY 20 TONS.—LONDON AND NORTH WESTERN RAILWAY CO.

ment, which can only be released by the adoption of some policy which will ensure a participation in the saving by both parties to the movement. It appears that this might be effected by altering the basis of the charges for mineral traffic from the net to the gross tonnage transported, making, of course, a corresponding reduction in the rate. Thus when 10 tons of coal are loaded in a wagon weighing 6·4 tons, the trader would be debited with charges on 16·4 tons, and if the rate were reduced in the ratio of 16·4 to 10, *i.e.*, by 39 per cent, the total payment to the railway company would be unaltered, but the trader would have every inducement to provide new wagons of increased capacity and to take care that no mineral wagons were sent out partly loaded. It may be urged that this course would involve a diminution in the gross receipts of the railways from a given volume of traffic when wagons of high capacity were introduced; but it is necessary to bear in mind the reduction in working expenses, the advantages due to the greater compactness of trains of equal weight, and to the better utilisation of space in mineral yards and sidings, whilst the weight to be returned empty is diminished by one-third. If the rate on the gross is reduced by one-third only of that on the net tonnage, a private owner would save 7½ per cent. of his charges by replacing standard 10-ton wagons by wagons of 36 tons capacity; his repair bill would also be reduced by one half; the railway company would have a direct saving of 15 per cent. in many of their principal items of expenditure and a gratuitous virtual addition of 77 per cent. to the length of sidings, &c.

The success of high capacity rolling stock in working traffic over the long hauls characteristic of American railways, appears to have led to the assumption that it is suitable only in cases where great distances are to be traversed, but this conclusion cannot be accepted as a logical deduction from the facts. In the case of general merchandise transported between neighbouring towns and collected and delivered by the railway drays, there is little doubt but that the terminal services do account for a large proportion of the cost of carriage. But heavy terminal expenses do not render the reduction of other working costs less desirable, whilst they have little bearing on the subject of mineral traffic. The effect of the

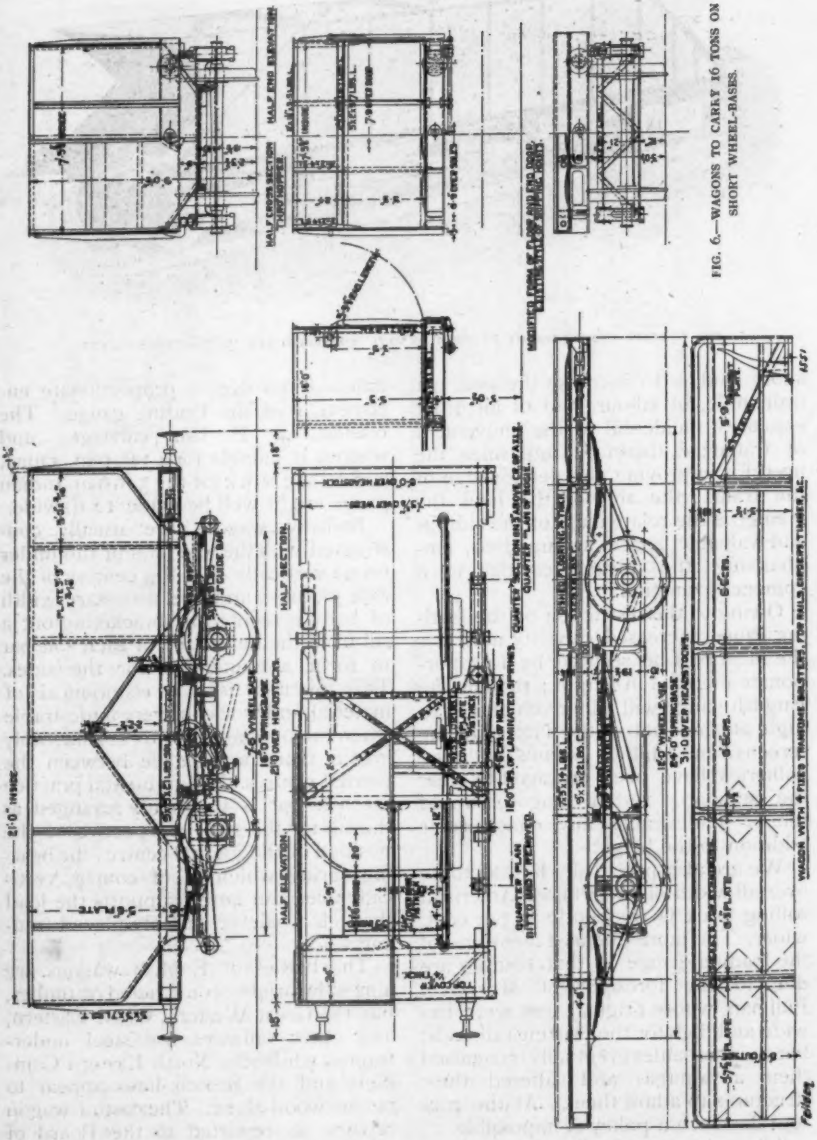


FIG. 6.—WAGONS TO CARRY 16 TONS ON SHORT WHEEL-BASES.

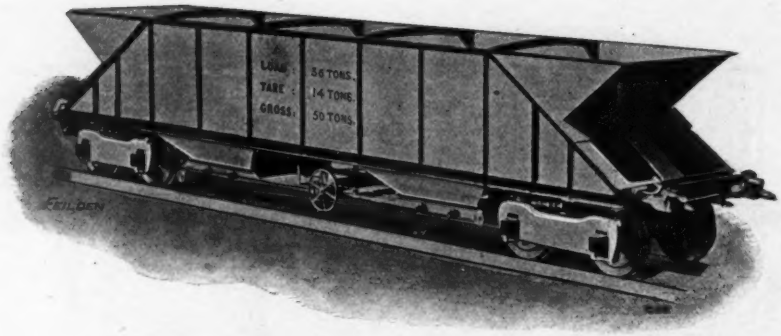


FIG. 7.—STEEL HOPPER WAGON TO CARRY 36 TONS. SHEFFIELD AND TWINBERROW'S PATENT.

short haul is to increase the cost per train mile, of labour, and of all other expenses incidental to the movement of traffic; it therefore intensifies the need for improving the net tonnage of the trains; the shorter the haul the greater is the relative use of the sidings and valuable space at junctions, emphasising the advantages due to a compact formation.

Owing to the restriction of the loading gauge, increased capacity must for the most part be secured by a proportionate increase in length; though the English gauge will admit vehicles 13 ft. high at the centre, the fact that the screens and filling spouts at the collieries have been arranged to clear the standard 10-ton wagon, would render undesirable any considerable addition to the height.

We are also practically limited to an over-all width of 8 ft., whereas American rolling stock is frequently 25 per cent. wider. The more liberal dimensions of the loading gauge in that country are due to the foresight of Mr. Geo. Pullman, whose original cars were too wide and high for the existing railroads, but the companies eventually recognised their advantages and altered their structures to admit them. At the present day such a policy is impossible.

A broad gauge of rails is a disadvantage from almost every point of view, unless it involves a proportionate enlargement of the loading gauge. The breadth of English carriages and wagons is suitable for a 3 ft. 6 in. gauge, and rolling stock for the 5 ft. 6 in. Indian gauge might well be made 12 ft. wide.

Railway wagons are usually constructed with the sole bars of the under frame vertically over the centres of the axle journals, and the necessary width of body is secured by bracketing out a sill from the outer face of each sole bar to form a foundation for the sides. This method is not economical of material, and would be very undesirable when the over-all width is considerably greater than the distance between the journal centres. In Continental practice the sole bar is frequently arranged as the sill for the side, irrespective of the position of the journal centre; the bearing spring, which is, of course, vertically over the latter, supports the load through a pair of suitably placed transoms.

The bodies of English wagons are almost invariably constructed of timber, but the Great Western, Great Eastern, and other railways, use steel underframes, whilst the North Eastern Company and the Scotch lines appear to favour wood alone. The cost of wagon repairs, as reported to the Board of Trade, does not indicate a pronounced advantage for either material, but it

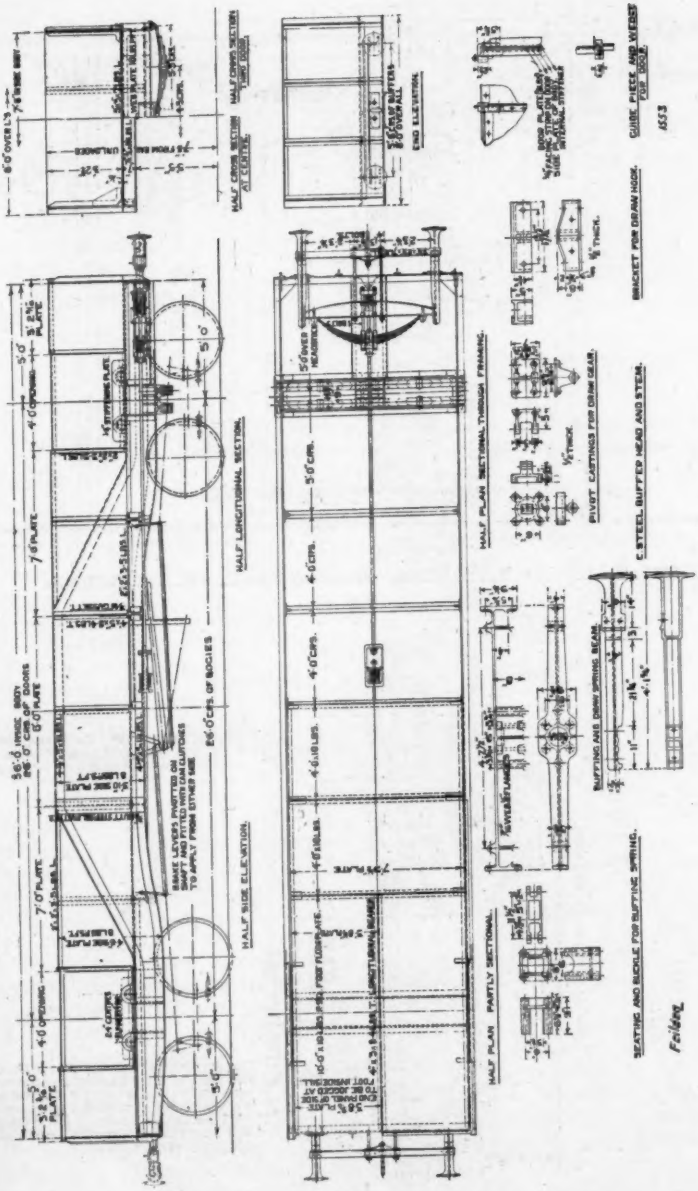
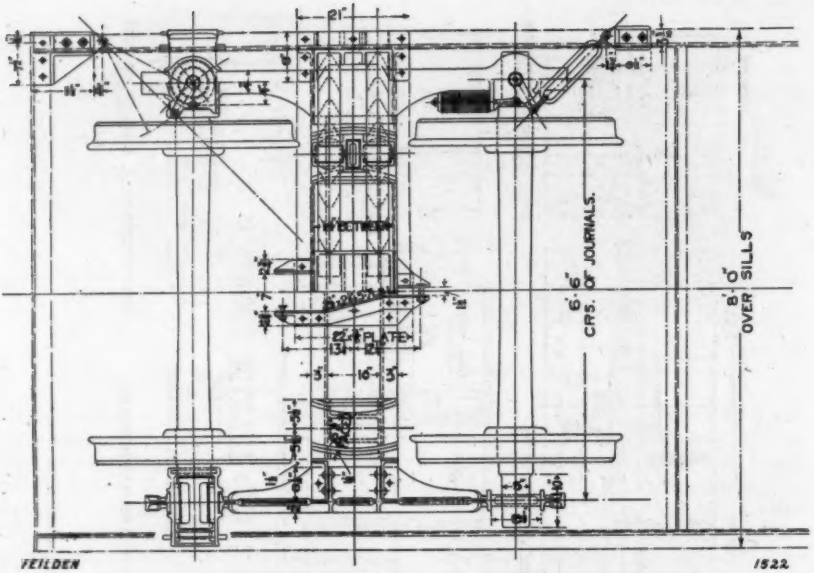

HALF SIDE ELEVATION.
HALF LONGITUDINAL SECTION.
HALF CROSS SECTION AT CENTRE
HALF CROSS SECTION THRU DOOR
END ELEVATION.
HALF PLAN PARTLY SECTIONAL.
HALF PLAN SECTIONAL THROUGH FRAMING.
SEATING AND BRACKET FOR BUFFING SPRING.
BUFFING AND DRAW SPRING BEAM.
PIVOT CASTINGS FOR DRAW GEAR.
C. STEEL BUFFER HEAD AND STEM.
BRACKET FOR DRAW HOOK.
GUIDE PIECE AND WEDGE FOR DOOR.
BRAKE LEVERS PIVOTED ON SHAFT AND FITTED WITH CAM CLUTCHES TO APPLY FROM EITHER SIDE
56'-0" INSIDE BODY
66'-0" C. OF DOORS
8'-0" PLATE
7'-0" PLATE
5'-0"
4'-0" OPENING
E6'-0" CRS. OF BOGIES
Failing.

FIG. 8.—WAGON TO CARRY 36 TONS OF BRICKS OR GRAIN.



HALF PLAN SHEWING BEARING SPRINGS. HALF PLAN OF BOGIE FRAME PARTLY SECTIONAL.

BOGIE FOR WAGON WEIGHING 50 TONS GROSS.

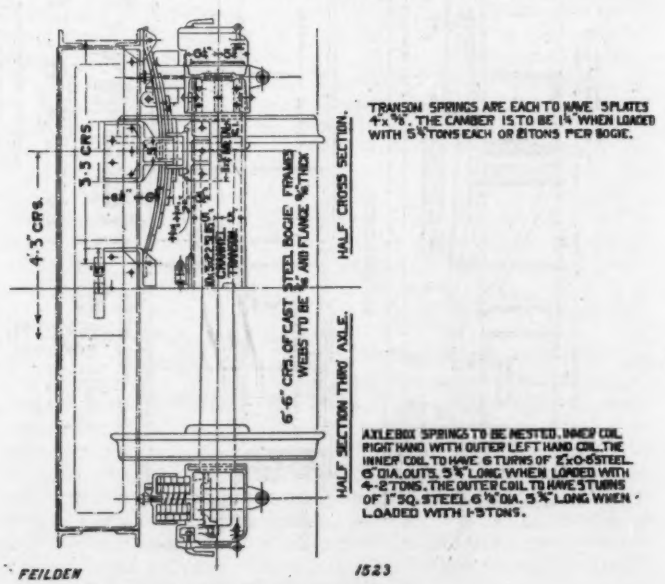

3'3 CRS.
4'3 CRS.
6'6" CRS. OF CAST STEEL BOGIE FRAMES WEBS TO BE ⅝ AND FLANGE ⅝ THICK
HALF CROSS SECTION.
HALF SECTION THRU' AXLE.
TRANSOM SPRINGS ARE EACH TO HAVE 5 PLATES 4"x⅝". THE CAMBER IS TO BE 1¼" WHEN LOADED WITH 5¼ TONS EACH OR 21 TONS PER BOGIE.
AXLE BOX SPRINGS TO BE NESTED. INNER COIL RIGHT HAND WITH OUTER LEFT HAND COIL. THE INNER COIL TO HAVE 6 TURNS OF 2"x0·6 STEEL 6" DIA. OUTS. 5¾" LONG WHEN LOADED WITH 4·2 TONS. THE OUTER COIL TO HAVE 5 TURNS OF 1" SQ. STEEL 6⅛" DIA. 5¾" LONG WHEN LOADED WITH 1·9 TONS.
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FIG. 9—BOGIE FOR WAGON WEIGHING 50 TONS.

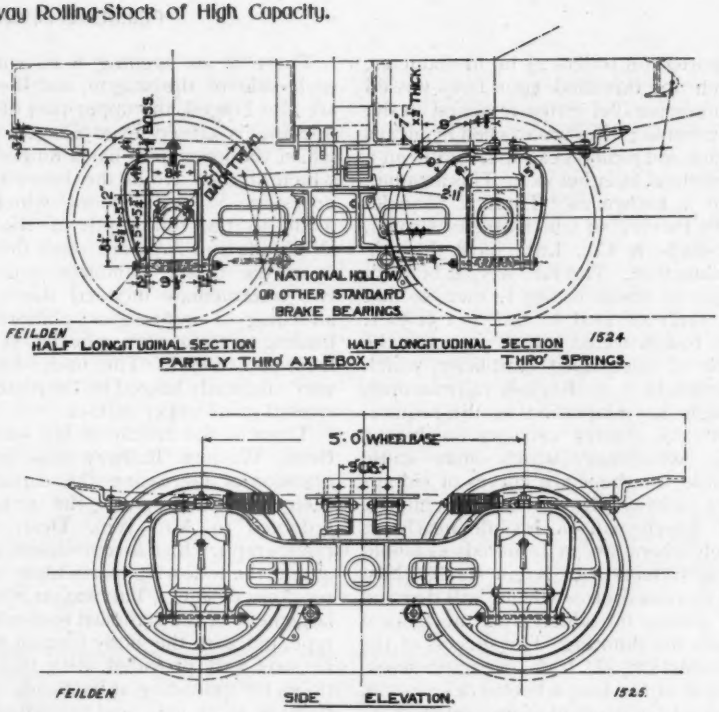


FIG. 9.—BOGIE FOR WAGON WEIGHING 50 TONS.

seems probable that, as in shipbuilding, the composite structure will slowly give place to the foremost material of the present age. There are two objections to the use of steel, viz., liability to corrosion and to deformation when subjected to extraordinary strain; the former may be combated by periodical scraping and repainting, which need not be a costly matter if the coating is applied by compressed air plants, which should be installed at suitable points; resistance to deformation may be immensely increased by adopting a more rigid form of construction, whereby the entire structure of the vehicle is combined into a resistant whole, instead of being divided, as at present, into a separate body to hold the load and a shallow frame to support the working stresses.

About five years ago, Mr. Charles Hunt, the chief engineer of the Windsor Str. Gas Works at Birmingham, found that considerable economy might be effected in handling coal within his works by the employment of 30-ton self-discharging wagons. Designs of bogie wagons were submitted by builders, but it was found that the railway companies refused to handle such vehicles, or to countenance any departure from the terms of their general specification for four-wheeled wagons. Mr. Hunt was therefore confined to the use of the customary design of steel under-frame, to which, in conjunction with Mr. A. L. Shackleford, he applied a hopper-shaped body constructed of steel plates converging to openings at the level of the underside of the sole bars (see Figs. 1 and 2); the doors are

supported on rollers 2⅞ in. in diameter, which are threaded upon bolts passed through parallel strips attached to the main frame ; they are worked by means of rack and pinion gear operated from a handwheel at either side. This arrangement is known as "Hunt & Shackleford's Patent," of which Messrs. Brown, Marshalls & Co., Ltd., have the sole manufacture. The tare weight of each wagon is about 6 tons 12 cwt., so that the ratio of load to tare is 1·51 to 1. The four-wheeled wagon possesses the merit of unequalled simplicity, which commends it to English railway men, though its adaptation to the requirements of greater capacity involves a long wheelbase which may cause trouble on the sharp curves of sidings or of railways through difficult country, and which will necessitate nearly as much alteration in terminals as would the introduction of bogie stock, whilst the increased gross weight will demand the general introduction of mechanical means for shunting. The success of the introduction of high capacity stock, even if of the four-wheeled description, is largely dependent upon a satisfactory solution of this question of terminals.

For some years past the Indian railways have employed wagons constructed entirely of steel and capable of carrying loads largely in excess of the general practice in this country. By the courtesy of Messrs. Sir A. M. Rendel & Co., the writer is enabled to give particulars of the standard low sided wagon of the East Indian Railway. This wagon, which is shown in Fig. 3, has two axles fixed at 11 ft. 6 in. centres and each designed for a safe load of 12 tons ; the maximum gross load is therefore 24 tons, and as the tare is only 6 tons 14 cwt., the allowable load is 17 tons 6 cwt., giving a ratio of load to tare of 2·58 to 1. The net content of the body is, however, only 478 cubic feet, equal to say 11 tons of coal, so that freight of ordinary density will require to be loaded high above the sides in order to obtain the full duty.

There is an opening 8 ft. wide at each side of the wagon, and the ends are also hinged, the upper part of each opening is closed by a flanged plate, whilst the lower part has a hinged flap, which division avoids the heavy labour necessary to close doors which are made to the full depth of the side. When the end flaps are open they rest upon the buffer standards and upon two intermediate inclined struts, thus affording a continuous platform for loading a train with wheeled vehicles from end to end. The under-frame is very efficiently braced by the plate floor riveted to its upper surface.

Towards the middle of last year, the Great Western Railway took up the question of increasing the capacity of their mineral wagons—the writer is indebted to Mr. Wm. Dean for a photograph, which is reproduced in Fig. 4, and the following particulars of the resulting design. The wagon is an enlargement of the standard four-wheeled type, but with the body formed wholly in steel and provided with two small doors for unloading at each side. The body is 20 ft. long and the wheel base is 12 ft., as compared with 8 ft. 6 in. or 9 ft. of the usual 10-ton wagons ; the main members of the frame are 12 in. × 3½ in. × ½ in. channel bars, whilst the springs, journals, and axles are proportioned for a gross load of fully 14 tons per axle. The net content of the body is about 615 cubic feet, so that 20 tons of ordinary coal would require to be heaped somewhat above the top curb. The tare weight is 8 tons 6 cwt. and the ratio of load to tare is therefore 2·41 to 1. The axle boxes are of the G.W.R. standard type, consisting of two castings jointed horizontally, the lower part forming an oil well which can be readily removed for examination and renewal of the lubricating pad. It may here be pointed out that this Company is now fitting oil boxes to all classes of rolling stock, following the practice of the L. & S. W. Railway, which gave up the use of grease many

years ago. All important foreign railways use oil only ; careful experiments on the Paris-Lyons Line demonstrated that the friction of grease boxes was 38 per cent. greater than that of oil at low speeds ; on the other hand the use of a solid lubricant permits of the employment of a cheaper pattern of axle box, but the lubricant must be frequently added, whereas a carefully designed axle box for oil will run many thousand miles without attention.

The London and North-Western Railway has also put into experimental service a similar type of wagon, and in order that it may form the basis for a standard pattern the parts most frequently requiring renewal, such as

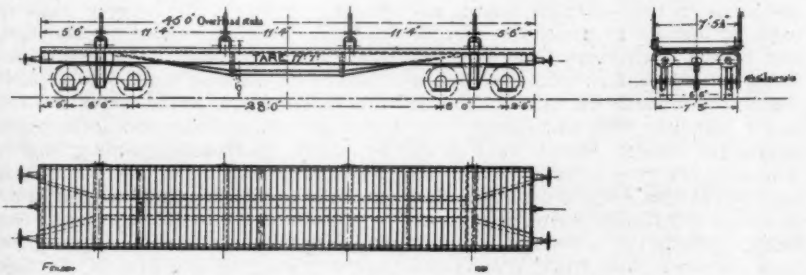


FIG. 10.—RAIL WAGON TO CARRY 40 TONS—GREAT WESTERN RAILWAY CO.

wheels, axles, springs, and brake are the same as those on the Great Western wagon. The writer is indebted to Mr. F. W. Webb for a photograph, reproduced in Fig. 5, and for the following description :—

"The subject of building mineral wagons of much larger capacity than those at present in use on our railways being under consideration, as an experiment, in June last year, Mr. F. W. Webb constructed at the Crewe works of the L. and N. W. Railway Company two light steel coal wagons, having a carrying capacity of 20 tons, the general construction of which is shown by the accompanying photograph. The body is composed of galvanised steel plates $\frac{5}{32}$ in. thick in the sides and ends and $\frac{3}{16}$ in. thick in the floor. The frame is made of 9 in. × 4 in. × $\frac{7}{16}$ in. channel bars, stiffened by 1 in. truss rods extending from one headstock to the other. The body is 21 ft. long by 7 ft. 9 in. wide and 4 ft. 2½ in. deep from the floor to the top of the curbing. The wheels are 3 ft. diameter and the journals of the axles 10 in. × 5 in. The brake is the Thomas patent, which can be applied from either side of the wagon. One of the features of this wagon is the automatic arrangement for indicating when the brake is on or off. This consists of a light cast iron frame with the words 'On' and 'Off' cast on, the frame being fixed immediately above the brake handle on each side of the wagon. On this frame the label box slides, being actuated by the brake handle. Supposing now that a man applies the brakes : on turning the handle to do this, he at the same time moves the label box till it comes in front of the word 'Off,' hiding it and exposing to view the word 'On.' So also when he releases the brake he moves the label box to the other side of the frame, thereby covering the word 'On' and exposing the word 'Off.' Thus a man walking down either side of a train is enabled at a glance to see whether the brakes are on or off."

The net content of this body is 684 cubic feet ; the plating in the sides and ends is $\frac{1}{32}$ in. thinner and in the floor $\frac{1}{16}$ in. thinner than that of the pre-

ceding example, and the under frame is built up of lighter sections, so that a saving of 8 cwt. has been effected in the tare weight, which comes out at 7 tons 18 cwt., the resulting ratio being 2·53 to 1.

These handsome vehicles have all the neatness of design and excellence of workmanship characteristic of the productions of their designers, but the length of wheelbase and the absence of means for rapidly discharging the load may be urged as objections which should be overcome in the endeavour to meet future requirements.

Early in 1898 the writer was engaged upon some designs of steel wagons in conjunction with his partner, Mr. G. H. Sheffield ; they then recognised that a four-wheeled wagon capable of loading 16 to 18 tons of coal and having a wheelbase suited to existing turntables, &c., would provide a useful step towards the introduction of larger vehicles ; they accordingly produced the design shown in Fig. 6. The axles are proportioned for a gross load of 12½ tons each, and are mounted in a truck at 7 ft. 6 in. centres, the frames being supported by a coil spring above each axle box ; the truck is extended beyond the axles at each end, where it is provided with seatings for laminated springs which afford a long supporting base for the body ; intermediate support is also provided by a pair of coil springs within the wheelbase at each side. The body is shaped as a double hopper, converging to openings placed beyond the axles and closed by doors which are carried by wheels running on the lower flanges of light channel bars ; the doors are worked by means of a central handwheel, geared to drums on which a pair of steel wire ropes are coiled. The design may be adapted for use with the end discharging style of tip used in South Wales by fitting a level plated floor, and by closing the ends of the wagons by means of doors hinged at the upper edges and secured to the headstock by bolts which may be released from either side in order to discharge the load, when the wagon is inclined by the platform of the tip. Side doors may also be provided if desired. The body plating is $\frac{3}{16}$ in. thick, and when loaded with 17 tons the ratio of load to tare is 2·2 to 1.

It is highly probable that the merits of the bogie system will eventually ensure the adoption of the eight-wheeled wagon for many classes of goods traffic in this country, just as it has succeeded in becoming the standard practice in connection with passenger carriages and engines, although the innovation appears to have been strenuously opposed in many quarters. Some ten years ago the writer was visiting one of the largest railway carriage works, and asked the Manager the reason for confining their productions to six-wheeled stock : he replied that bogie stock would never do for their railway, and they did not approve of other companies sending eight-wheeled carriages on their through trains ; for several years past, this same works, under a new Manager, has been building bogie stock only. Again, it is not very long since a firm of carriage and wagon builders completed some trains of bogie cars for one of the Southern railways and tendered them to a certain railway for delivery to destination, but the locomotive department refused to handle them, and finally, after much correspondence, agreed to transport them on slow goods schedule, at a speed not to exceed 25 miles an hour. At the present day the principal express trains on that railway consist of bogie stock only, and the comfort of the travelling public is greatly enhanced thereby. Physical obstacles are not always the only or least serious difficulty to be surmounted in connection with the introduction of improvements.

The hopper wagon is unequalled for the facility it affords for rapidly discharging the load, and for the simple

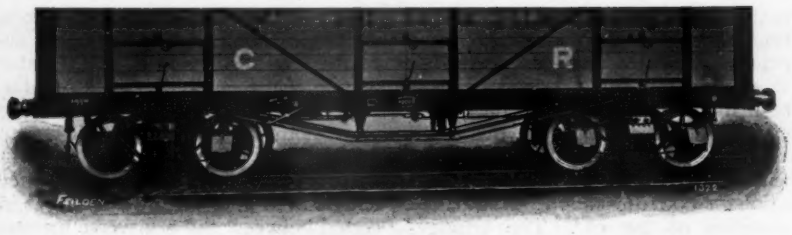


FIG. 11.—ORE WAGON TO CARRY 50 TONS.—CALEDONIAN RAILWAY CO.

if somewhat special character of the terminal plant necessitated. An example of a double hopper bogie wagon to carry 36 tons of coal is shown by Fig. 7. Each side is built as a rigid plate girder extending between the headstocks; these girders are united by stiff transoms of box section over the bogies, by the inclined plates of the hoppers and by four bulb bar stays across the upper flanges; the hoppers are continued down to a convenient level above the rails and are edged with channel bars upon which run the rollers for supporting the doors; their spindles are thus shielded from the falling coal and are always accessible for lubrication; a handwheel at either side drives a drum shaft through suitable gearing, and wire ropes are so connected as to operate the doors simultaneously; if preferred, the doors may be arranged to work independently.

The continuous drawbar, brake pull rods, &c., are fitted within a middle longitudinal member, which is built up of two pressed sections in the form of a flattened tube; this form affords little obstruction to the free downward passage of the coal.

When it is required to discharge the load through side doors at platform level the construction is modified as shown in Fig. 8. In this case the top flanges of the side girders are horizontal and flush with the flooring for a length of 7ft. 6in. at each end; they are then inclined upwards and form the curb of the sides at the centre; the lower flanges are also set up to come flush with the floor transoms near the middle of their length. The flooring of 10lb. plates is rivetted directly to transom joints placed at 4ft. centres and strongly united to the side stiffeners; the transoms over the bogies are extra deep and are built up of plates and angles. There are openings in the side above each bogie, the doors are mounted on rollers to slide outwards for opening, thus avoiding the many inconveniences attendant upon the use of hinged doors.

The bogies upon which these wagons are mounted possess some novel features, the object of which is to avoid the disadvantages of the ordinary type. The general practice of carrying the load on a central pivot necessitates heavy frame transoms to support the main longitudinals, and imposes a heavy bending moment on the bolster or the transoms of the bogie frame; moreover, the centre pin exerts no control over the angular movements of the bogie, the position of which is consequently defined by the pressure of the flanges against the rail, so that there is a tendency to cross binding between the wheelbase and the gauge of rails, and this is particularly marked when the axles are not widely spaced. In the design in question the bogie is united to the frame by four radiating links; these are provided with cushion springs which undergo compression when angular motion takes place, and which oppose the lateral forces. The load is

received on sliding shoes of ample surface through two pairs of plate springs, which are arranged accessibly for examination and overhaul beneath the main transoms. The main frames of the bogies are supported over each axle box by means of a compound helical spring, graduated for efficient action for both the loaded and unloaded condition of the car. The arrangement is illustrated by Fig. 9.

The bogies used under the passenger carriages of the G. W. Railway support the load directly from the side frames by means of suspension links, which are secured through spherical washers at their lower ends to cross beams, rigidly attached to stanchions riveted to the sole bars. The same principle has been adopted in the construction of flat bolster wagons to carry rails as shown in Fig. 10. A horn plate stiffened by a vertical channel bar is riveted to the outer face of each sole opposite to the centre of the bogie; the lower ends of each pair of plates are attached to a cross bar which passes beneath the bogie frame, and is supported directly to that frame by means of suspension links fitted with spherical bearings and with coil springs.

A train of long wagons, when fitted with the European system of side buffers, is liable to bind on curves when tightly coupled, and if the couplings are slack the same action takes place when the train is being pushed, owing to the considerable angle existing between adjacent headstocks; a short vehicle when coupled between bogie wagons would also be liable to derailment, unless the buffers are equalised, in order to permit the wheelbase to assume its natural position independently of the inclination of the centre lines of adjacent vehicles.

A means for effecting this is shown in Fig. 8, where the buffers are rigidly united to a rectangular frame, the inner transverse member of which bears against a laminated buffing spring; the latter is supported by tie bolts which pass forward to a central pivot about which the buffers are free to turn. The position of this pivot is at the intersection of the centre line of a standard wagon with that of the bogie wagon when both vehicles are in their correct positions on any curve; it therefore follows that the buffer heads will meet truly and in line. A draw spring is inserted between the transverse member and the pivot; when a continuous draw bar is required the stiffness of this spring is proportioned to the resistance of its own wagon alone, the resistance of the following wagons being taken up by a stronger spring in the draw bar cradle.

The Caledonian Railway was the first among British lines to introduce passenger and goods locomotives of greatly increased hauling power, and in seeking to enlarge the capacity of the carrying stock, Mr. J. F. M'Intosh was not the man to confine his effort to a mere increase in size of the ordinary four-wheeled wagon, whilst American railways were successfully using cars to hold 44 tons of freight.

He accordingly built for experimental use in the import ore traffic the class of wagon shown in Fig. 11. The inside measurements of the body are 34 ft. 7 in. × 7 ft. 7 in. × 4 ft. deep, yielding a net capacity of 1,049 cubic feet; it is intended to carry 50 tons of iron ore, and is massively constructed in every detail. The under-frame is of steel, and has four longitudinal members of 10in. × 3½ in. channels, stiffened by truss rods, the transoms over the bogie pivots are trussed, as are also the 9 in. × 3½ in. channels forming the bogie bolsters; the latter bear upon coil springs which rest on the lower members of the diamond frames of the bogie trucks. The body is constructed of 2½ in. planking, bolted to T-bar uprights and fitted with L-bar sills and curbs, there are three pairs of doors in each side, swinging on vertical hinge pins, the floor boards are armoured with ⅛ in. plates. The design is remarkable for solidity and strength rather than for an attempt

to cut down the tare to an irreducible minimum.

The space at our disposal forbids the inclusion of a detailed description of the steel cars manufactured in America by the Pressed Steel Car Company, of Pittsburgh, but the success of this Company's designs is indicated by the fact that the number of all-steel cars put into service during 1899, was four times that of the deliveries during the preceding year, and that the combined home and foreign demand now greatly exceeds the capacity of the supply.

J. D. Twinberrow.

The Simplon Tunnel.

(By Our Special Commissioner.)

Of the many gigantic engineering works of our age, the building of the Simplon Tunnel is undoubtedly one of the most noteworthy, and, judging from the progress so far made, we may safely predict its completion, under nominal conditions, within the stipulated time, *i.e.*, by April 13th of the year 1904.

After the Italian Government had approved the financial estimates provided for in the international agreement between Italy and Switzerland, dated November 25th, 1895, both Governments ratified this agreement, and the directors of the Jura-Simplon Railway, on August 13th, 1898, handed over the required territory on either terminus to the Simplon Tunnel Building Company (Messrs. Brandt, Brandau and Company), and authorised the beginning of the work.

At the Swiss terminus (Brig) the preparatory work had already begun before the concession had been granted. At the Italian terminus (Isella), however, this had not been possible, since, before the ratification, permission had been granted merely for the erection of a shed ; and, in fact, not before the end of December, 1898, was the authorisation given on the part of the

THE VILLAGE OF SIMPLON

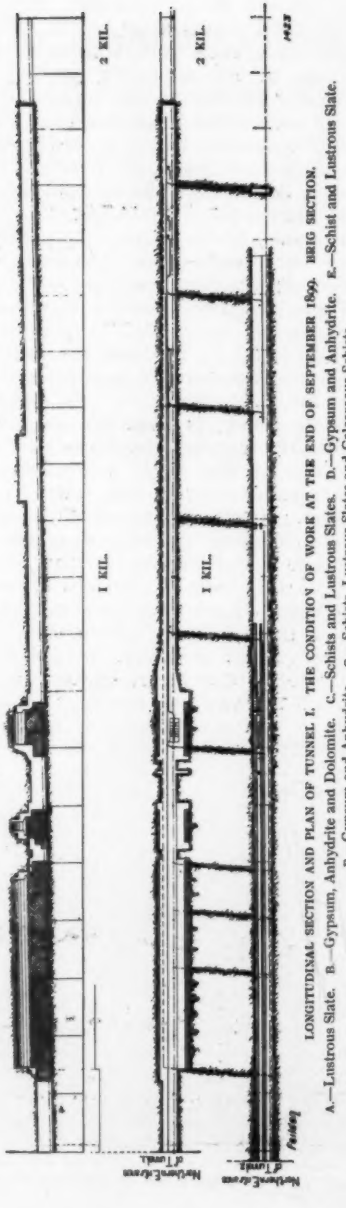
Italian authorities to begin the blasting of the rock with dynamite.

The plan drawn up in 1893 has been slightly modified, and the essential measurements are as follows: The tunnel will have a length of 19,770 m. (12·4 miles), beginning in Switzerland near the little town of Brig, in the valley of the Rhone, and ending near Isella, in the valley of the Diveria, in Italy, piercing the base of the Monte Leone, in the Alps, in a direction from N.W. to S.E. When completed, it will be the fourth of the great Alpine tunnels, those previously constructed being the Mount Cenis, the St. Gothard, and the Arlberg tunnels, having a length respectively of 12,849 m., 14,984 m., and 10,240 m. The Simplon Tunnel begins at the northern side of the Alps with a curve of 140 m. (152·6 yards) in length, with a radius of 350 m. (381·5 yards), which continues with a straight line of 19,321·8 m. (11·9 miles), followed by a curve of 185·5 m. (202·9 yards) in length, with a radius of 400 m. (437·6 yards), and ending in another straight line of 122·7 m. (134·2 yards). The straight line of a length of 19,321·8 m. (11·9 miles) is prolongated on either side by a guide-level, that on the northern entrance having a length of 134 m. (145·5 yards), while the southern has a length of 276 m. (301·8 yards). The axis of the long straight line forms an easterly angle of 128° 48′ 18″ with the N.S. direction of the meridian. The northern entrance is situated 685·83 m. (750 yards) above sea-level. The level then rises 2 per 100 for 9,148·1 m. (10,004 yards) to the culminating point 704·2 m. (770·1 yards) above sea-level, continues horizontally for a length of 500 m. (547 yards), then descends with a 7 per 100 grading for a distance of 10,086 m. (11,030 yards) and ends at the southern entrance 633·60 m. (692·9 yards) above sea-level.

While the three other Alpine tunnels have been constructed for a double track of railway, the Simplon Tunnel is to consist of two parallel tunnels 17 m. (18·5 yards) apart,* built for a single track each, and connected at intervals of 200 m. (218·7 yards) by transverse passages. The vertical section of each of the single-track tunnels, after the masonry facing is completed, has an interior area of 23·20 m.² (27·74 yards); the width at the base is 4·50 m. (4·92 yards), and at a height of 2 m. (2·18 yards) above, 5 m. (5·4 yards), while the height from the base is 5·50 m. (5·9 yards).

There are five different kinds of cross-section (see Plate) provided for: (1) in the rock where pressure is absent and the strata of rock are regular; (2) in the rock where a simple masonry facing is required and the strata are irregular, the lateral facing and that of the vault to consist of quarry stones, and to have a width of 0·35 m.; (3) in the mountain where there is medium pressure, the lateral facing to consist of quarry stones, and that of the vault of squared stones, both facings to have a width of 0.50 m.; (4) in the mountain where there is strong vertical pressure, the lateral facing to be of stratified masonry, and that of the vault of squared stones, both to have a width of 0·60 m.; (5) in the mountain where the lateral

* NOTE.—The United States Consul at Berne, in his official report dated December 12th, 1899, must have entirely misread the specifications of the contract, and makes an absolutely incorrect statement regarding the manner of building the tunnel, for (Consular Reports, Vol. LXII., No. 234, p. 317) he says: "The method employed by Engineer Brandt, who has been in charge of the undertaking, is to drive two holes parallel within the radius of the excavations, leaving a dividing line, one hole being excavated about 17 metres (55⅞ ft.) *in advance* (N.B. The Italics are ours) of the other. These are built for a single track, and *later on the dividing wall can be broken through for a double track if necessary.*" (!!) In reality, however, the words in the German text of the contract (p. 10), "*Zwei eingeleisige Tunnel, in einem Abstand von 17 m.*," mean "two single-track tunnels *at a distance of 17 m. from each other*," and not *in advance* of each other. That this is the meaning is also shown in the plates accompanying the contract, portions of which, on a reduced scale, we publish in the present number of our magazine. The dividing-wall, therefore, of which the United States Consul at Berne assumes that it may later be broken down if required, has a *thickness of 17 m.* (55⅞ ft.); in fact, as will be seen further on, it is so broad as to contain passage-ways for side-tracking, if necessary, locomotives and railway cars: and when it is borne in mind that the tunnels themselves have a maximum diameter only of 5 m. each, it will be seen that the "breaking down" of this wall would be a work far more gigantic than the excavation of both tunnels together.



LONGITUDINAL SECTION AND PLAN OF TUNNEL I. THE CONDITION OF WORK AT THE END OF SEPTEMBER 1899. BRIG SECTION.

A.—Lustrous Slate. B.—Gypsum, Anhydrite and Dolomite. C.—Schists and Lustrous Slates. D.—Gypsum and Anhydrite. E.—Schist and Lustrous Slate. F.—Gypsum and Anhydrite. G.—Schists, Lustrous Slates and Calcareous Schists.

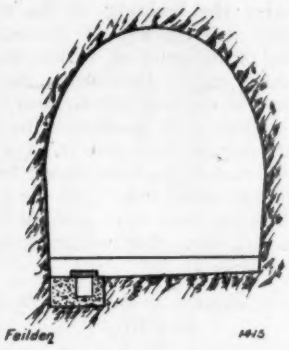
pressure is strong, and the rock is crumbling, the lateral facing to consist of stratified masonry, the inverted vault facing of the base to have a width of 0·40 m., and the upper vault facing of squared stones a width of 0·60 m.

At intervals of 100 m. each are to be constructed small recesses 2 m. wide and 2·30 m. high, and at every 1,000 m. little chambers to be set into the rock for the placing of the bell signals and the lamps. These chambers will have a width and a depth of 3 m., and a height of 3·10 m. There will be, besides these, four larger recesses, distributed at equal distances over the whole length of the tunnel, and serving the purpose of storing the implements for keeping the track in repair. These larger recesses will have a width of 4 m., a height of 3·10 m., and a depth of 6 m. In the middle of the tunnel a portion 400 m. in length will be excavated to permit two trains to pass.

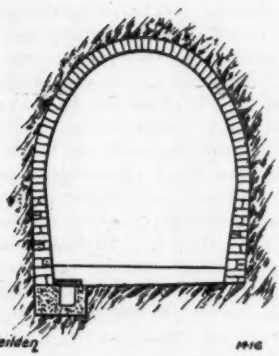
The base galleries on both sides, drilled in order to stake out the axis of the tunnel, will have a width of 3·70 m., and a height of 3·85 m. The parallel gallery will have a facing only in those portions where there exists pressure. It will serve for the conduit pipes, through which all the water from the first main tunnel will be led off.

The geological formations through which the Simplon Tunnel will pass, enumerated from south to north, are : (1) Micaceous schist, with pearl mica and Antigorio gneiss, 6,330 m. ; (2) Teggiolo chalk, pearl mica, micaceous schist and gneiss, Vallé chalk, stratified gneiss, and gneiss with micaceous schist, Vallé schist, gneiss and micaceous schist, Monte Leone schist, crystalline slate and gneiss, chalk of the Ganter, crystalline slate and stratified gneiss. 9,700 m. ; (3) lustrous slate (glanzschiefer), with the gypsum banks of the Rhone, 3,700 m.

The strata are almost vertical to the tunnel axis, and the rock is of a kind

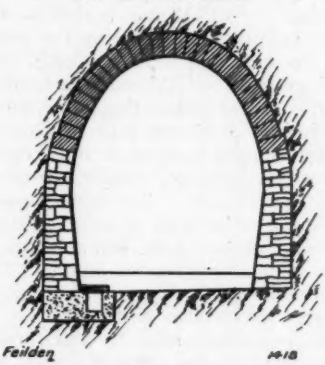


NORMAL CROSS-SECTION OF SINGLE TRACK TUNNEL WITHOUT MASONRY FACING.

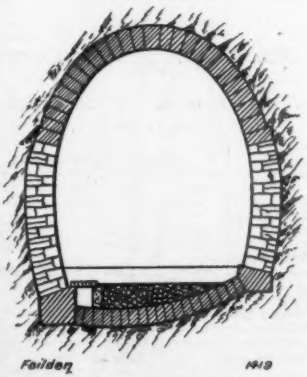


NORMAL CROSS-SECTION OF SINGLE TRACK TUNNEL WITH MASONRY FACING.

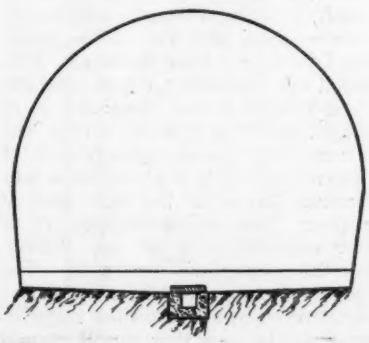
NORMAL CROSS-SECTION OF SINGLE TRACK TUNNEL MEDIUM PRESSURE.



NORMAL CROSS-SECTION OF SINGLE TRACK TUNNEL STRONG VERTICAL PRESSURE.



NORMAL CROSS-SECTION OF SINGLE TRACK TUNNEL STRONG LATERAL PRESSURE.



INTERIOR AREA OF CROSS-SECTION OF DOUBLE TRACK.

favourable for mechanical drilling. On the northern side the drilling will proceed swiftly, as the rock is not very hard, though the facing will somewhat hamper speedy progress. In the central portion and through the Antigorio gneiss, where the rock is harder but compact for long distances, masonry facing will not be required, and the mechanical drilling can proceed steadily, since Mr. Brandt's hydraulic rotary drilling machine can be regulated for all degrees of hardness. Gypsum and dolomite strata are the most dangerous for tunnelling, but these occur only for short distances.

Of paramount importance in the building of an Alpine tunnel is the water supply obtainable for the work. On the northern side the water was obtained from the Rhone and at a place about 1,100 m. below the little hamlet of Moerel, deflected into a channel having a length of 3,200 m. and a cross-section of 3·70 m^2, yielding 5 m^3 of water per second. The high pressure conduit, consisting of a tube having a cross-section of 1·6 m., has a length of 1,500 m., and crosses the Rhone. The effective height is 44·5 m. and the water supplies the turbines with 2,225 h.p.

On the southern side the water power is supplied by the Diveria and is deflected near the Swiss-Italian frontier, where it is carried in a high-pressure conduit, 4,210 m. in length, and having a cross-section of 0·9 m. to the installations on the southern entrance. This conduit has a portion 1,160 m. in length of cast-iron, while the remainder is of wrought-iron ; it passes across the Diveria in two places, and a portion of it, 200 m. in length, is placed in a subterranean channel on the right bank of the river. The minimum quantity of water supplied is 1 m^3. per second, while the average will be 1·4 m^3. The effective height which is 158 m., respectively 139 m., furnishes 1,475 to 1855 h.p. In case this supply should prove insufficient, additional water is obtainable from the Cairasca.

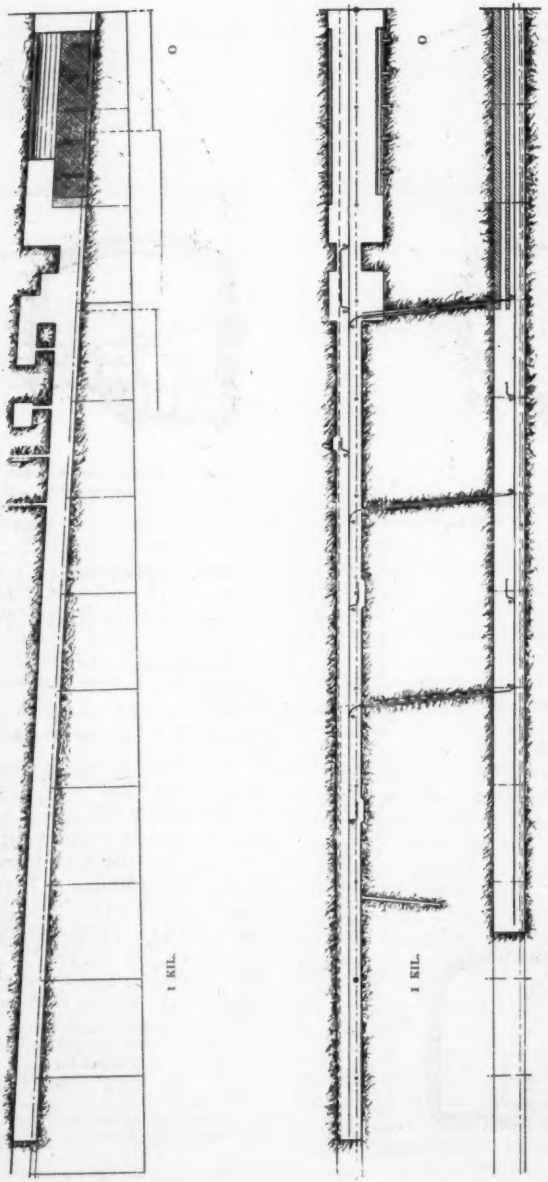
Besides the building of the water-conduits, the making of roads, the building of houses and workshops, the erection of engines and drills, the laying down of electric lighting and ventilation plants, etc., comprise the preliminary installations which were, for the most part to be completed by the end of last year (1899), and for which the following sums were granted to the contractors, upon the recommendation of experts :—

A.—Installation on the Northern Side (near Brig.)

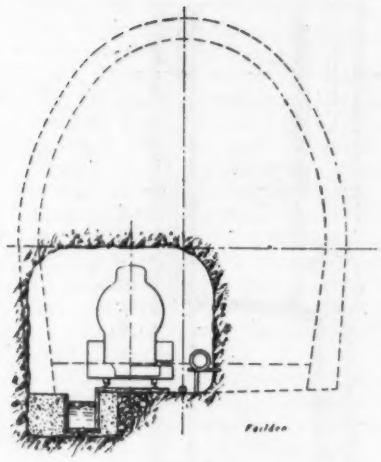
Object.	Expenditure in Francs.			
	1898	1899	1900-1903	Total
a. Construction (exclusive of the narrow-gauge railway	126,000			126,000
b. Water Power ...	10,000	1,080,000		1,090,000
c. Mechanical Appliances & Steam Engines	105,000	——		105,000
B. Pumps	52,000	73,000	225,000	350,000
Pipe Lines in Tunnel	120,000	259,000	402,000	782,000
Schieber, &c. ...	15,000	95,000	50,000	160,000
Drilling Machines	78,000	167,000	505,000	750,000
Workshops... ...	71,000	26,000	——	98,000
Provisory Ventilation	25,000	8,000	——	33,000
Final Ventilation	——	55,000	——	55,000
Electric Lighting	15,000	30,000	19,000	64,000
	782,000	713,400	1,201,500	2,397,000
d. Superterrene Structures :				
1, Installation Buildings ...	250,000	370,000	——	620,000
2, Dwellings...	132,000	81,000	——	213,000
3, Hospital ...	——	78,000	——	78,000
	382,000	529,000	——	911,000
Total ...	1,000,100	2,322,400	1,201,500	4,524,000

B.—Installations on the Southern Side (near Isella).

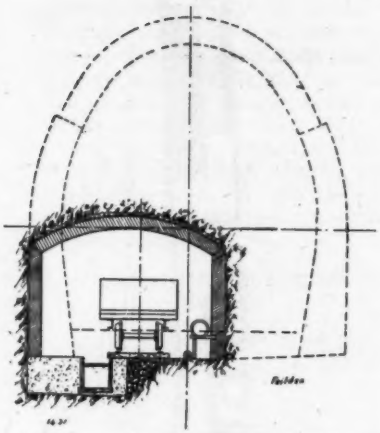
Object.	Expenditure in Francs.			
	1898	1899	1900-1903	Total
a. Subterranean Construction ...	122,000	113,000	——	235,000
b. Water-Power...	55,000	1,040,000	——	1,095,000
c. Mechanical Appliances	482,100	712,400	1,201,500	2,397,000
d. Superterrene Structures :				
1, Installation Buildings ...	199,000	449,000	——	648,000
2, Dwellings...	234,000	137,000	——	371,000
3, Hospital ...	——	75,000	——	75,000
	433,000	661,000	——	1,094,000
Total ...	1,102,100	2,527,000	1,201,500	4,831,000



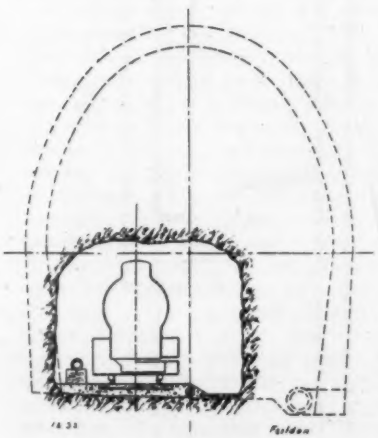
ISELLE SECTION. THE CONDITION OF WORK AT THE END OF SEPTEMBER 1899. LONGITUDINAL SECTION AND PLAN.



CROSS-SECTION OF BASE GALLERY IN SOLID ROCK, TUNNEL II.



CROSS-SECTION OF BASE GALLERY IN DIFFICULT GROUND, TUNNEL II.



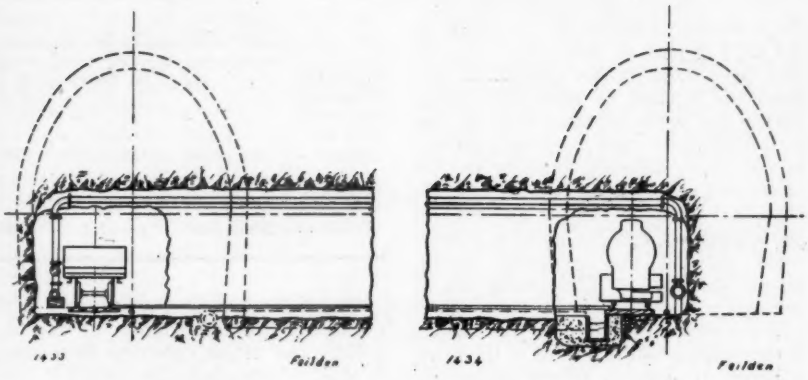
CROSS-SECTION OF BASE GALLERY, TUNNEL II.

Total Expenditure for Installations.

Object.	Expenditure in Francs.			
	1898	1899	1900-1903	Total
a. Northern Side (Brig.)	1,000,000	2,322,400	1,201,500	4,524,000
b. Southern Side (Isella)	1,102,100	2,527,400	1,201,500	4,831,000
Grand Total ...	2,102,000	4,849,800	2,403,000	9,355,000

The work to be finished during the years 1898 and 1899 was practically completed by the end of last year. As the above tables show, the amount to be paid for the outside installations is 9,355,000 francs. The agreement, signed September 20th, 1893, made allowance for 7,000,000 francs only, for this kind of work, but the modification was made by mutual agreement. The original provisions were as follows :

For the completion of Tunnel I. and a parallel gallery in Tunnel II. ...	47,500,000 fr.
For the completion of Tunnel II.	15,000,000 fr.
Adding to this for the outside installations	7,000,000 fr.
The total price for the construction is to be	69,500,000 fr.



LONGITUDINAL SECTION OF TRANSVERSE GALLERY.

(In this amount are not included the cost of acquiring the ground needed for the installations, the track-laying (Oberbau) in the two tunnels and the ballasting of Tunnel II.)

The contract further provides that Tunnel I. must be completed within 5½ years in case the date on which the authorisation to work is given falls within the period from February 1st to July 31st, and within five years and eight months in case it falls within the remaining period of the 12 months. The authorisation was granted in reality on August 13th, 1898.*

For the construction of Tunnel II. the period of four years is allowed from the date of its inception, which will be four years after completion of Tunnel I. In case the work has not begun by that time, the contractors are freed from the obligation of constructing Tunnel II. The contractors deposited on the date of signing the contract a sum of 1,000,000 fr. as security, which during the course of construction will be increased by 7 per cent. of the payments to be made on account, *i.e.*, to the amount of 5,000,000 fr. After the completion and the taking over of Tunnel I., there will yet remain 2,000,000 fr. as deposit for two years; after these two years there will remain a deposit of 1,000,000 fr.; and for another three years more a sum of 500,000 fr. In case the building of Tunnel II. is commenced within the stipulated time, the remaining deposit of 500,000 fr. is to be gradually raised by adding 7 per cent. from the payments to be made on account of the work for Tunnel II., to 1,500,000 fr., and after completion of Tunnel II., there are still to remain 500,000 fr. as deposit for another two years. For each day that the time-limit is exceeded a fine of 5,000 fr. will have to be paid by the contractors, while for each day that the work is completed before the stipulated time a gratuity of 5,000 fr. will be paid to them. The contract is to be annulled if the contracting company is dissolved, or remains behind in its work for the period of one year, and, in either case, the deposit is forfeited.

* NOTE.—Here again the United States Consul at Berne is totally mistaken as regards the cost and the period of construction, for he says in the beginning of his report (l.c.p. 316): "*On November 13th, 1898, work was begun on the Simplon Tunnel. The contract calls for its completion in five and one-half years, and the price to be paid is 69,500,000 francs* ($13,413,500)." The sum he mentions is that which will be paid for the completion of *both* tunnels, for which a period of *13 years* and *8 months*, dating from Nov. 13th, 1898, is allowed, while for the completion of Tunnel I., together with a parallel, unfinished, gallery in Tunnel II., for which a period of five years and eight months is granted, only 47,500,000 fr. (including installations) is to be paid.

The conditions clearly stipulate that the contractors undertake the work at the fixed prices at their own risk, and that these fixed prices include all expenditure caused by obstacles arising during the work, whether they be due to the influx of water, high temperature of the rock, difficult territory in the mountain, or any other causes, excepting a war in which Italy or Switzerland are implicated, epidemics, or a general strike without the company having given cause for it. The staking out of the axis is the duty of the contractors, and the method of building the tunnels is determined by the boring of the three galleries in advance of the mainwork, after which the facing with masonry is to follow. In general, the whole cross-section is to be broken out and faced with stones, only where there exists no pressure the contractors may, after drilling out the calotte, finish the vault, break down the stope (die Strosse) and construct the lateral facing.

Payments, according to agreement, are to be made monthly, and the following working programme has been drafted :—

	Gallery of Base.	Parallel Gallery.	Top Gallery.	Complete Excavat'n.	Facing with Masonry.
Work to be completed according to programme...	m. 2,697	m. 2,697	m. 2,279	m. 1,679	m. 958
Work actually completed ...	3,866	3,468	1,454	1,419	1,030

This indicates a very satisfactory progress, for the retardation of the top gallery and of the complete excavation is of little importance, because this kind of work can easily be forced if necessary.

The bulletin published in March of the present year shows that by the last of February the boring at the northern end had reached a length of 2,593 m., and at the southern end a length of 1,838 m., the total therefore being 4,431—*i.e.*, 14,538 feet, which shows an average of slightly over 900 feet per month for the two first months of the year. This slight decrease is not astonishing, as the rate of work attained at the beginning is never maintained in a work of this nature ; but, owing to the ingenious plan devised by engineer Brandt, the difference will never be very great, barring unforeseen acci-

Year.	Gallery of Direction.	Gallery of Base and Parallel Gallery.		Top of Gallery.		Complete Excavation.		Facing with Masonry.		Ballasting, &c.
	Total m.	m.	Total m.	m.	Total m.	m.	Total m.	m.	Total m.	Total m.
1	420	1,900	1,900	1,500	1,500	900	900	200	200	—
2	—	3,700	5,600	3,600	5,100	3,600	4,500	3,500	3,700	—
3	—	4,100	9,700	3,900	9,000	3,800	8,300	3,900	7,600	—
4	—	7,600	14,300	7,600	13,600	4,500	12,800	4,400	12,000	—
5	—	5,100	19,400	5,200	18,800	5,400	18,200	5,500	17,500	—
Last half year.	—	330	19,730	930	19,730	1,530	19,730	2,230	19,730	19,730

According to the bulletins published by the company the work completed by the end of last year, as compared with the work to be completed according to the programme, is shown in the following table :—

dents. This plan provides, as has been stated already, for two single-track tunnels instead of one double-track tunnel, as in all previous cases of tunnel-building through the Alps. From the very beginning there have been drilled, both on the northern and on the southern side, two parallel borings 17 m. apart, connected at intervals of 200 m. by transverse galleries. While, however, the boring in Tunnel I. is being enlarged to its full size step by step, the boring in Tunnel II. will not be finished until the traffic in Tunnel I.—which in the middle has a portion 400 m. in length, permitting two trains to pass—has become greater than can be managed with a single track.

Meanwhile the parallel gallery in Tunnel II., however, having a clear cross section of 8 m.², has a very important part to play, for it serves as a ventilating tube. For this purpose it is closed at the entrance by a large-sized gate, and air is introduced by powerful ventilators. The transverse galleries also, excepting always the two end galleries, are closed, so that the air entering through the longitudinal boring in Tunnel II. is forced through this boring, passes then into Tunnel I. through one of the transverse galleries, and, having supplied fresh oxygen to the workers inside, escapes to the outside. In this way a fresh air supply is secured, far greater in amount than could be obtained if there were only one tunnel. At the same time, by means of this ventilation, the temperature is kept down so successfully that the maximum temperature at the head of the workings on the northern portion is 23·6 deg. C. (74 deg. F.), and on the southern heading 30 deg. C. (86 deg. F.) only.

The parallel boring, however, offers still other advantages, in so far as it permits all the water accumulating to be led off in Tunnel I., both such as is introduced by pipes for working purposes and such as enters from the mountain where the drilling cuts through the bed of subterranean springs. In this gallery also the great water ducts required during the later periods of work can be securely placed and protected. Not less important is this boring in Tunnel II. for removing the excavation material, for the trucks used for that purpose enter this gallery and return by Tunnel I., so that an obstruction of traffic, such as for a considerable time existed at the northern end of the Gothard Tunnel during the excavation of km. 2, is rendered impossible. All this shows that this parallel boring helps to solve in the most satisfactory manner some of the most serious problems arising in the construction of long tunnels. The completion of Tunnel I. proceeds in the accustomed manner. After drilling the base gallery, the top gallery is bored, the whole opening is widened, and the inside, where required, is faced with masonry, while at a later period Tunnel II. will be completed without interfering in any possible way with the traffic in Tunnel I. Repairing work in the latter, notwithstanding its length, will offer no greater difficulty than such as would occur in a small tunnel 200 m. in length, for by the transverse galleries by which labourers and material can enter and leave, the great tunnel is in reality divided into a series of 200 m. tunnels.

The drilling work is done by engineer Brandt's powerful hydraulic rotary machines, which can be worked coupled parallel or in series, and which are an object of keen interest to all engineers that visit the neighbourhood, while another of his inventions is a machine for loosening and removing the fragments of rock after the blasting operations. This is done by directing a powerful jet of water amongst the *débris* in order to wash away the dirt and the smaller particles. Several of these machines are employed in the tunnel and work in rotation.

The blasting operations are carried on in a very economical manner. Dur-

ing the last three months of 1899, for instance, there were removed from the Swiss end 4,916 cubic metres of rock, at the expenditure of 19,947 kilogrammes of dynamite ; while from the Italian end the quantity of rock removed was 25,336 cubic metres, at a consumption of 5,109 kilogrammes of that explosive. Consequently at the one end 4·06 and at the other end 4·96 kilogrammes of dynamite were required per cubic metre, which is a very low expenditure, and considerably less than that of the preceding three months. Experience is constantly teaching less costly methods and new discoveries simplifying the work are constantly being made ; among the latter may be mentioned the use of liquid air mixed with marl, oil, or other materials as an explosive. Experiments with this new explosive have been inaugurated recently, but no results have as yet been published.* The death of Mr. Brandt is, no doubt, an event deeply to be regretted ; but it will hardly interfere with the progress of the work, and it may safely be assumed, as we have said in the beginning, that the two tunnels will be finished within the stipulated time, if not before. It is a somewhat extraordinary coincidence that Louis Favre, the engineer of the St. Gothard Tunnel, also died of apoplexy, like Mr. Alfred Brandt, during the course of construction of the work he had planned, and the completion of which was left to others.

* These experiments have since been abandoned.

G. G.

MACHINERY APPLIANCES AND PROCESSES.

" Every part and side of our life, from the cradle to the grave, has been touched and tended by the inventor and manufacturer. His works are as numberless as the sands of the sea, but the onward rush of Science and the Arts opens up new fields of discovery and enterprise as each day dawns. Let us choose here and there among thousands, and in choosing take the best as far as in us lies."

"LUCAL" PORTABLE PETROLEUM LAMP.

MESSRS. LUCAL, LTD., recently supplied some of their large lamps to a foreign Government, and when, a short time ago, that Government passed a law requiring all trains to carry a certain number of torches, it was suggested to the Lucal Company that they might try to turn out something that would be light and portable and at the same time give a powerful light, and after some experiments this lamp was the result.

It is nothing more or less than a small portable oil gas plant.

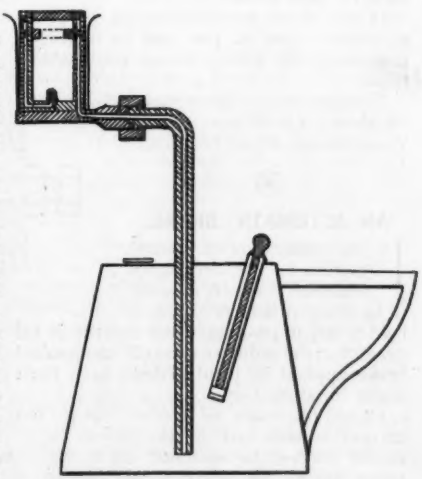
The accompanying sketch shows the construction of the lamp. There is a small reservoir of oil, into which a powerful little pump is inserted which effects a pressure on the oil, causing it to pass up a tube to the head or burner of the lamp. This head is really a small tubular boiler, and the oil in its passage through it becomes vapourised and comes out at the burner in the form of a highly inflammable oil gas.

To light the lamp a small piece of waste, saturated in petroleum, is inserted in the head and lighted ; it is allowed to burn for about two minutes, by which time the tubes have become very hot. The pressure is then put on and the waste removed, and as the gas comes out at the burner it becomes ignited and intense blow-pipe heat is obtained. There is a covering sheath that sends the flame up and cools it down to an illuminating heat, and a light of 250 to 300 candle power is the result. The lamp will burn at from 1 to 30 lbs. pressure per square inch, but it gives from 250 to 300 candle power at 15 lbs. pressure, and at that will burn for four hours, with occasional pumping to keep up the pressure.

The lamp with two pints of oil weighs 6 lbs., and with petroleum at 6½d. per gallon costs rather under ½d. per hour at the pressure quoted above. Oil of a specific gravity of under 830 should be used, as the tubes are of small diameter and with a crude oil are liable to become choked.

The orifice of the burner is exceedingly small, and a pricker is provided to keep it open. The head of the lamp can be turned to any angle, so that the light may either have a vertical or horizontal direction, so that if it is being used in a high wind it may burn in the direction of the wind, and so cannot be blown out.

There is a small air valve by which the



THE "LUCAL" PORTABLE PETROLEUM LAMP.

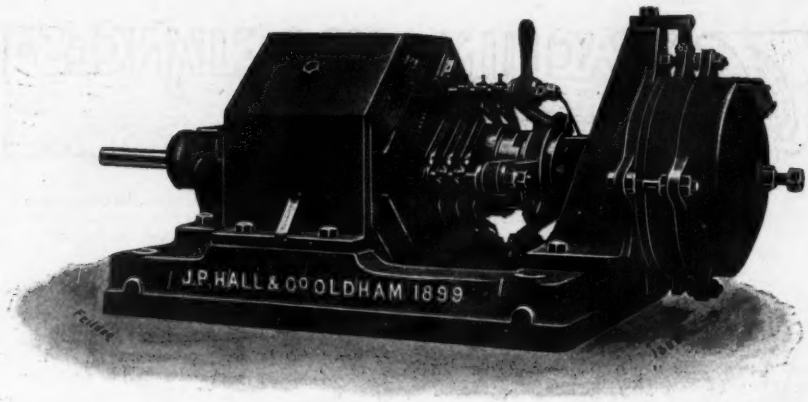


FIG. 1.—SHEWING BRAKE FITTED TO A MOTOR.

pressure on the oil can be reduced, and the lamp can thus be extinguished instantly.

It will prove invaluable in railway works, especially in tunnels as well as in pits.

A contrivance is being adapted whereby the flame can be used for heating purposes, and it will prove very useful for applying heat locally to plates or rails for welding purposes or for melting lead and heating irons for pipe work.

In fact, there are innumerable purposes to which it can be put, and its lightness, cheapness, and power should commend it to all.

They are solely manufactured by Messrs. Lucal, Ltd., of 121, West George Street, Glasgow.

AN AUTOMATIC BRAKE.

IN the application of electric motors to the driving of machinery which requires to be stopped with precision or held firmly in position when current is off the motor, the ordinary forms of mechanical brake applied by hand or foot have been found unsatisfactory.

Should the brake be applied before the current is switched off the motor, or should current be switched on to the motor before the brake is released, an excessive current will flow, resulting in any case in the inconvenience of a blown

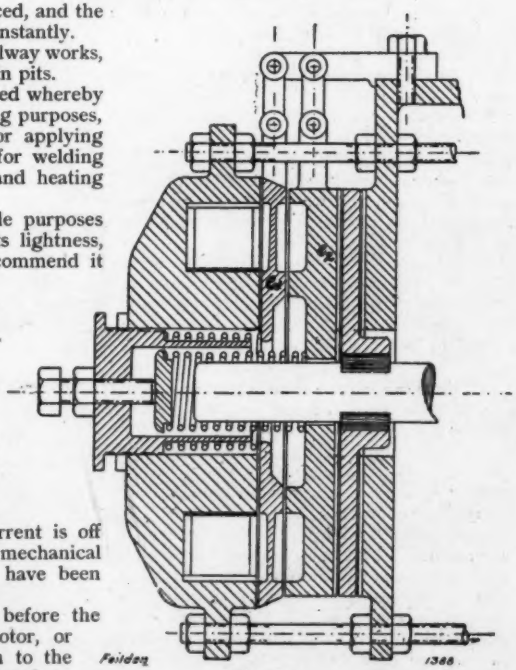


Fig. 2

FIG. 2.—SHEWING THE BRAKE ARRANGED TO GIVE TWO PRESSURES.

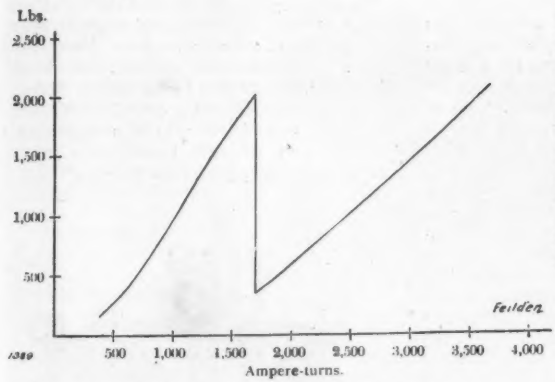


FIG. 3.—TRACTIVE FORCE CURVE FOR BRAKE.

fuse and possibly in the greater inconvenience of a burnt armature.

To avoid these troubles, the brake which we illustrate has been devised. It may be applied either to the shaft of the motor itself or to one or other of the shafts of the machine which the motor drives.

The brake, which is automatic, is normally held on by a spring and is released by an electro magnet, the exciting current of which is controlled by the switch which starts and stops the motor. Thus when the switch turns current on to the motor it releases the brake and when it turns the current off, the brake renews its grip, so that the attendant has only the one handle to manipulate and does not need to think about the brake at all.

In construction it is somewhat similar to the Weston friction clutch. A disc slides on a feather key on the motor shaft, and is placed between two plates, one of which is fixed to the frame of the machine, and the other swings on a link and is provided with stops to prevent rotation. This moveable pressure plate is acted upon by a spring which squeezes it, the disc, and the fixed plate tightly together, so that the motor shaft cannot turn.

An electro magnet is provided which, when energised, pulls the pressure plate back and releases the disc. In Fig. 1, an illustration is given of one of the brakes fitted to a motor for driving a set of plate-bending rolls, the object being to get quick stops in definite positions without having to wait for the momentum of the motor and gearing to die down with the possibility of stopping short or over-running. The users have found this a great advantage, as they are now able to get more work out of their rolls than they could before the brake was adopted. Generally a simple on and off brake is all that is needed, but in cranes handling loads which require fine adjustment, it is desirable that the brake should exert an intermediate pressure between full on and full off. The sectional drawing Fig. 2 shows a brake arranged to give two pressures. There are two pressure plates, e_1 and e_2, and there are two springs, one pressing on each plate. The magnet switch in this case requires three points:—"off," "on," through a resistance, and "on" to the magnet direct. The tractive force curve for one of these brakes is given in Fig. 3. This brake is intended to exert a total pressure of 4000 lbs. with an intermediate pressure of 1650 lbs. The plates e_1 and e_2 each exert a pressure of 2,000 lbs. Referring to the curve it will be seen that as the ampère turns round the magnet increase, its attraction increases, till at 2,000 lbs the plate e_1 is pulled over, leaving the plate e_2 still pressing on the disc. At this point the attraction (which is now exerted between e_1 and e_2) falls to 375 lbs. owing to the magnetic short-circuit formed by e_1. As the ampère turns are further increased the thin part of e_1 becomes saturated, and the magnetic potential across it rises, causing the attraction to increase till at 2,000 lbs. the plate e_2 is also pulled over, leaving the disc free.

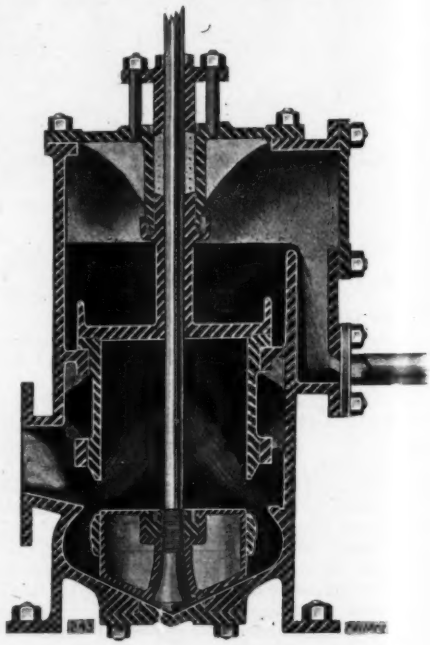
The patentee of the brake is Mr. Claude W. Hill, M.I.E.E., and the makers are Messrs. J. P. Hall & Co., Werneth, Oldham.

THE EDWARDS PATENT AIR PUMP.

THOSE who have had considerable experience of the working of air pumps of the ordinary kind cannot have helped noticing their defects and realising that they are by no means ideal machines. Mr. Fred Edwards, one of the members of

the late Marine Research Committee of the Institute of Mechanical Engineers, has published an interesting pamphlet explaining the working of an improved type of air pump designed by him, from which we gather the following facts that may be of interest to our readers. His chief aim, it seems, was to abolish the foot and bucket valves, which he considers to be obsolete. He points out that in the ordinary air-pump, where the water is raised by difference of pressure, or, as it is commonly called, "suction," the pressure in the condenser has to be sufficiently above that in the pump, to overcome the resistance due to the inertia of the water and the foot-valves, in order to force the water into the pump. Though at slow speeds the difference of pressure is small, at high speeds, when the water has to be started in motion and stopped again, and when the foot-valves have to be opened and closed several times per second, it is greatly increased. Moreover, in the ordinary pump little attention is given to the air; no provision is made for its free access to the pump, in fact its admission is obstructed by its having to pass through the valves and water before reaching the barrel. Mr. Edwards, by abandoning the foot-valves, has remedied this feature, and in his pump the water flows continuously by gravity into the base of the pump, where it is dealt with mechanically by a conical bucket, working in connection with a base of similar shape, as shown in our illustration. In this way the water is driven upwards silently and without shock and is projected through the ports into the working barrel. The ascending water is followed by the ascending bucket, which closes all the ports simultaneously before the inertia of the water in the barrel is overcome by gravity. A noteworthy feature of this device is, that the speed of the water corresponds to the speed of the bucket, thus permitting the pump to be driven at very high speeds, and, as the amount of water dealt with at each revolution is practically constant, there is no danger of sudden flooding causing violent shocks, which so often occur in the ordinary type of pump. In the Edwards pump, when the ports are first opened by the descending bucket they are left free to the entrance of the air, while the water, injected immediately afterwards, tends to compress the air in the barrel, taking more air with it on the principle upon which an injector is based.

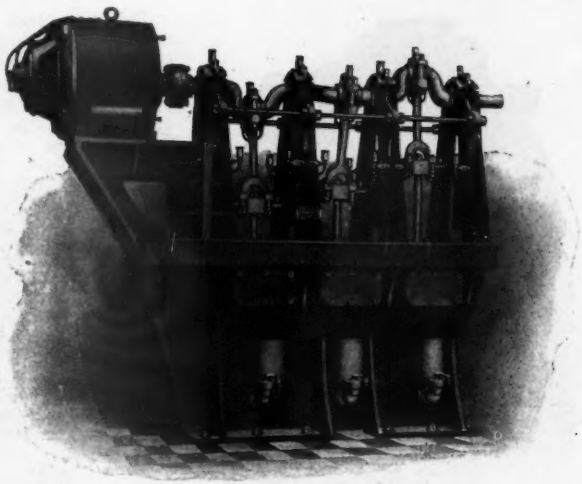
By abandoning the foot and bucket valves which, in the ordinary pump, require pressure in the condenser to raise them, Mr. Edwards has effected a considerable saving of power and avoided losses which, though appearing insignificant if considered singly, are very considerable in the aggregate. Thus a loss of one horse-power on a vessel carrying 5,500 tons of cargo does



SECTIONAL VIEW FROM PHOTOGRAPH OF MODEL TAKEN WHILE IN ACTUAL OPERATION AT 70 R.P.M.

not seem to be worthy of much notice, but on a long run, say from London to Hong Kong, occupying 1,053 hours, the number of foot-tons lost thereby would be equal to power sufficient to raise the whole cargo, (*i.e.* 5,500 tons), vertically, a distance of 169 feet; and even more serious is the loss of an inch of vacuum if continued over such a period of time. The L. P. cylinder of a steamer, such as would be required for transporting the cargo mentioned, may be taken as of 72-inch diameter, × 48-inch stroke, 58 mean revolutions, and on a run from London to Hong Kong the

foot-tons lost by an inch of vacuum would be equivalent to the force needed to raise vertically the whole steamer and cargo complete to a height of 3,249 feet, or, over half a mile. Taking this into consideration, even a slight improvement of the efficiency of an air-pump becomes of considerable importance, and the aim of engineers should be to maintain in the condenser a pressure approximating as closely as can be to the lowest theoretical pressure, *i.e.*, that corresponding to the temperature of the condensed steam.



MOTOR DRIVEN TRIPLE AIR PUMP ON EDWARDS PATENT PRINCIPLE.

With the ordinary air-pump the pressure which is at all times necessary in the condenser to overcome the resistance between the condenser and the pump is increased as the speed is increased, and the efficiency of the pump is proportionally reduced. In the case of the Edwards pump, according to the designer, a high speed does not affect its efficiency, and to prove this the following results, recently obtained and certified, are quoted :

Revolutions per minute.	Vacuum in inches.	Barometer in inches.	Temperature of Air-Pump. Discharge in degrees Fahrenheit.	Pressure due to Temperature in inches.	Difference between vacuum obtained and highest vacuum theoretically possible.
240	30·2	30·85	65	·619	·03
250	29·6	30·8	83	1·1	·1
375	28	30·45	107	2·369	·081

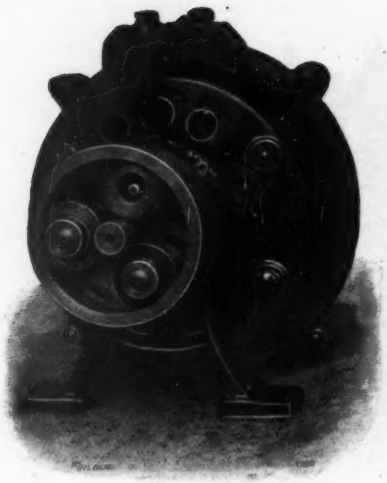
From these data it appears that the Edwards pump can be driven at a speed which, when the motive power is electricity, renders it possible and economical to couple the motor to the pump crank-shaft direct, which is a great consideration in many cases.

To point out some further advantages of his pump, Mr. Edwards draws attention to the fact that the top clearance is reduced to a minimum, whereas this is large in the ordinary pump and causes a considerable loss of efficiency. From data supplied by the engineers of the chief engine and boiler companies, we understand that more than 20 per cent. of the total number of engine break-downs are due to the defects in the ordinary air-pumps and of these 11·2 per cent. are caused by the failure of bucket valves, foot valves, &c., while in the Edwards pump, accidents to valves are practically eliminated. Under these circumstances it is not surprising to learn that there are few marine builders who have not adopted the Edwards pump. It is becoming equally popular for land installations also.

BALANCED SPEED REDUCER.

DESIGNED AND BUILT BY MESSRS. BROWN & CO., of MANCHESTER.

THE "Speed Reducer" described below, a device for regulating the speed of any machine, decreasing or increasing it or reversing, if desired, the motion, consists of a central pulley, or roller, fastened to the high-speed shaft. Around this central roller are placed three others,



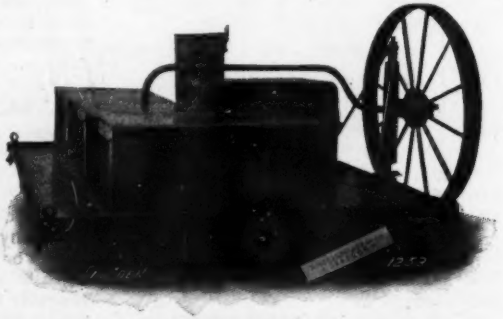
NEW SPEED REDUCER BY MESSRS. BROWN AND CO.

which, situated at approximately equal distances from each other revolve freely on pins. By means of an outer ring their outward pressure is counteracted, and they are held firmly against the central pulley, so that the whole apparatus is balanced in all directions. Since there are no sliding surfaces, and all the contacts are on rolling surfaces, friction is reduced to a minimum. In our illustration, the motor is seen with the ordinary end-bearing removed and replaced by the Speed-Reducer, which, on the one hand, acts as a roller bearing for the shaft, and, on the other hand, serves for transmitting the power. Connection with the machine is easily established, either by belting or gearing, or by direct coupling; and the outer ring is supported by, and rolls upon, the intermediate rollers, without notable friction. In all types of this Speed-Reducer the pressure of the surfaces is counter-balanced by the resistance of the rotary motion, preventing slip, reducing wear and regulating the pressure to the amount required for driving the load.

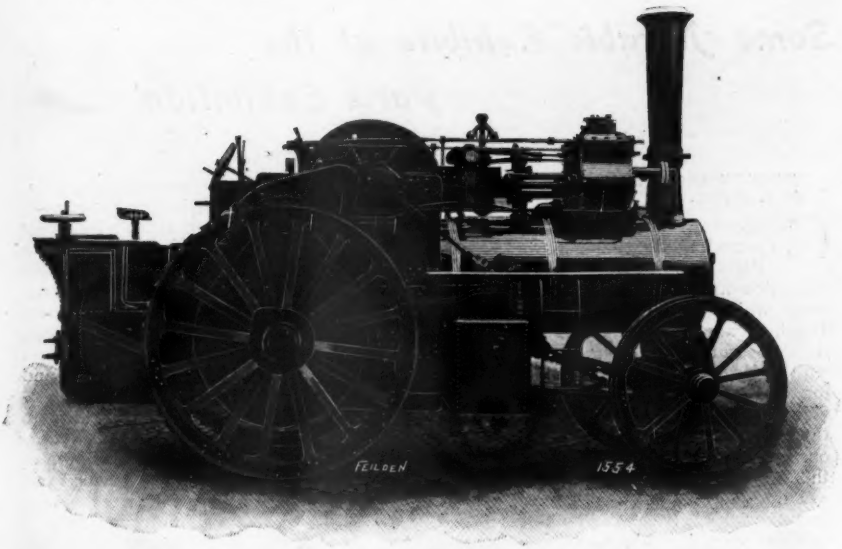
There are two methods of driving by belt with this Speed-Reducer, when the latter is to be used in connection with very high-speed motors. In the standard arrangement, shown in the illustration, the belt pulley forms the outer ring and is carried by the rollers on which it rests. By this arrangement, which works very satisfactorily, the speed may be reduced from 10 to 1. From the belt pulley or ring, connection can be made to an ordinary coupling, *i.e.*, a direct-coupling with the shaft of the machine may be established, or the outer ring may serve as a spur or bush gear ring, and thus gear-driving may be substituted. The latter mode is preferable for printing machines when the space is too limited for belt driving. Another arrangement consists of a small pulley on the side of the encircling ring, and carried by arms from it. This small pulley is bushed to fit the motor shaft, which revolves inside of it, but with far greater speed. A motor running at 1,800 revolutions per minute, and driving a 14 in. pulley will run at 70 revolutions per minute, a reduction of 26 to 1.

SINGLE RAIL ELECTRIC TRUCK.

SINGLE rail trucks are largely used in India and in South America for transport purposes. The South American plan is to attach the balancing boom or outrigger to the ox or mule which draws the load. In India a wheel is used at the end of the outrigger and the load is so distributed that the weight is chiefly carried by



SINGLE RAIL ELECTRIC TRUCK.



PATENT COMPOUND TRACTION ENGINE EXHIBITED BY MESSRS. CLAYTON AND SHUTTLEWORTH AT THE YORK SHOW.

the rail wheels and but slightly overbalanced on the side of the road wheel. Such trucks are drawn by oxen. The truck illustrated has been built by Mavor & Coulson, Ltd., of Glasgow, for service in India. Each of the two wheels (which run on the same rail),is driven by independent chain gear from the motor spindle. The accumulator is carried, as shown, under the platform. The truck is intended to carry a load of 5 cwts., and in addition to draw two trucks, each carrying 1 ton, at a speed of eight miles per hour.

PATENT COMPOUND AGRICULTURAL LOCOMOTIVE.

BY MESSRS. CLAYTON AND SHUTTLEWORTH, LINCOLN.

THE most important novelty exhibited at the York Show of the Royal Agricultural Society was the Compound Traction Engine manufactured by Messrs. Clayton and Shuttleworth.

In the engine illustrated the slide valves are placed on the top of the side by side cylinders, and the valves are actuated by Joy's radial gear, which ensures an excellent distribution of steam to both cylinders.

The slide valve faces and valve rod being parallel with the centre line of the cylinders, the slide valves are more easily tooled and readily accessible for setting, examination and repairs.

In this arrangement of engine, eccentrics are dispensed with for working the slide valves ; the two speed first motion gearing can be placed inside the box brackets in a four shaft compound engine, without crowding.

The same gearing can be used throughout as for a single cylinder traction engine.

By this patent an economy of space on the crankshaft is effected which permits of the introduction of three speed gearing when desired.

High pressure steam can be admitted to the low pressure steam chest for starting, so that the engine for the time being will work as a double cylinder engine.

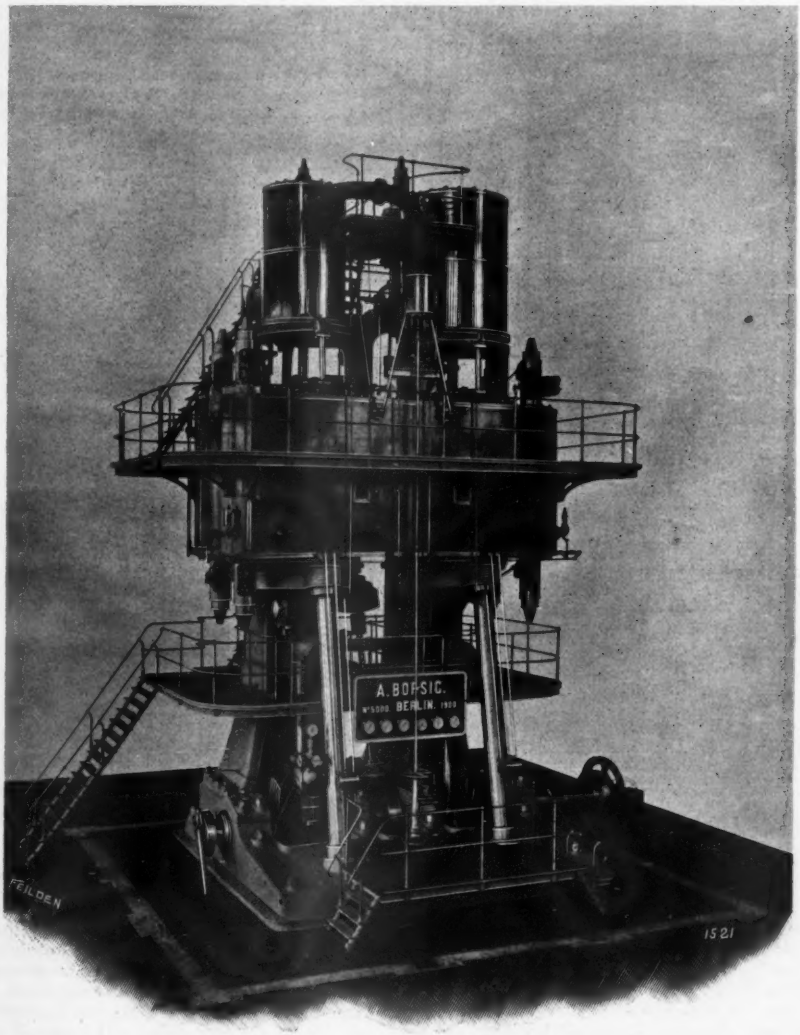
The engine is made under Shuttleworth and Fletcher's patent No. 16668, 1899, and is specially recommended for economy of fuel and water, noiselessness in work and steady running.

Some Notable Exhibits at the Paris Exhibition.

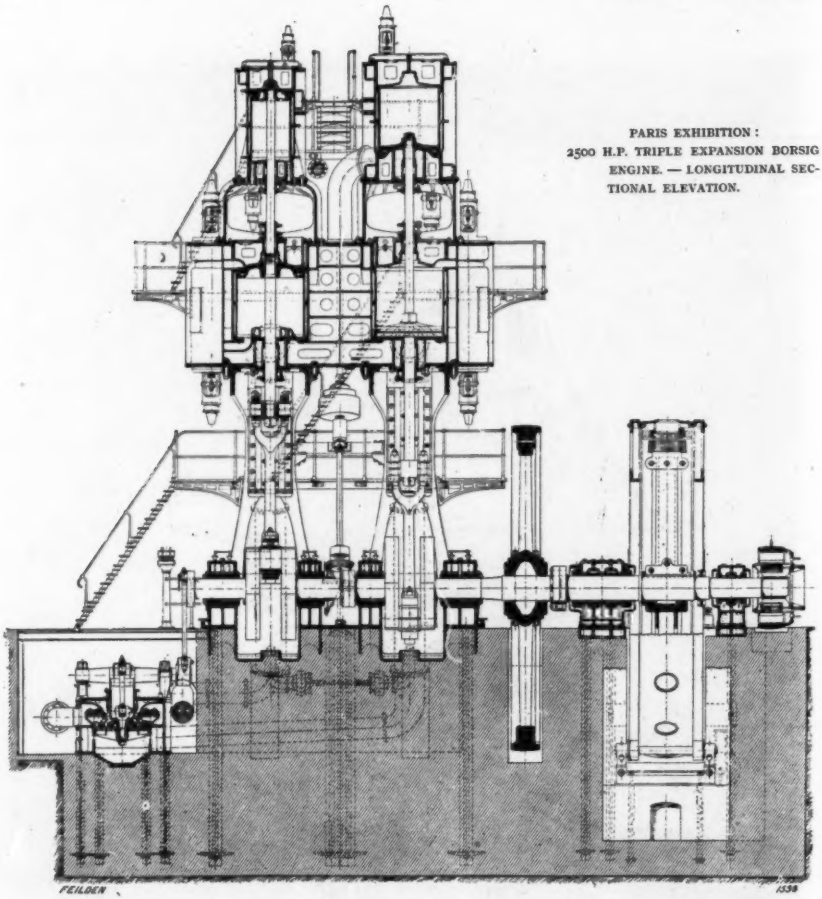
TRIPLE EXPANSION ENGINE BY A. BORSIG.

CONSPICUOUS among the engines for providing light and power at the Paris Exposition is the great triple expansion engine illustrated in our present issue, which was designed and built at Tegel, near Berlin, by the well-known German firm of A. Borsig, and is coupled with a large Siemens and Halske alternator of large size, intended chiefly for providing current for lighting the buildings in the Champs de Mars. As will be seen from our illustration, it is an upright engine, with the cylinders arranged on the plan now usually followed, *i.e.*, of dividing the low-pressure work between two cylinders placed tandem with the high and intermediate cylinders respectively. The high-pressure cylinder is 760 mm. (29·9 in.), the intermediate 1,180 mm. (46·4 in.), and each of the two low-pressure cylinders 1,340 mm. (52·7 in.) in diameter; the stroke being 1,200 mm. (47·25 in.); the normal speed 90 revolutions per minute. With an initial pressure of 14 atmospheres (199·1 lb. per square inch) when working condensing, and with about 20-fold expansion; the engine develops 2,500 b.h.p.

Mounted on the crankshaft, which consists of two parts, at one end is a crank disc, driving two coupled vertical single-acting air pumps placed on the cellar floor 2,500 mm. (8·2 ft.) below the engine floor, while the dynamo shaft is coupled to the other end of the crank-shaft, and rests upon two massive bearings provided with ring lubrication and adjustable on the base-plates. The alternating current dynamo is placed between these bearings, while the exciter is mounted on the outer end of the shaft. The baseplate of the engine consists of two parts securely attached to each other, each half carrying two crank-shaft bearings, and is hollowed out between them in the form of a trough for collecting the droppings of oil which are forced up into a purifier by means of two small rotary pumps driven by steel wire ropes from the crank-shaft, whence it returns to the portions to be lubricated. Between the base-plate and the large dynamo bearings is mounted the heavy flywheel weighing 41,000 kg. (41½ tons), provided with a toothed ring, on which acts a spurwheel set in motion by an electromotor when the engine is to be started. The base plate also carries two strong cast iron pillars supporting the guides, and two steel columns set in large eyes on this plate and also in similar eyes at the top of the cast-iron pillars, which gives great rigidity to the engine. The two firmly-coupled low-pressure cylinders are mounted on top of the pillars, and above them are placed two cast iron stools, well stayed by intermediate wrought iron pillars, which former support the high-pressure and intermediate cylinders. All the cylinders are provided with steam jackets, each heated with the steam of its own cylinder. The high-pressure cylinder piston is fitted with Ramsbottom cast iron rings, while the three others have Buckley rings of the latest pattern. All the pistons are of cast steel. The stools placed between the upper and lower cylinders are so constructed that, after the intermediate stays have been removed, the upper covers and pistons of the low-pressure cylinders can be dismounted. The piston rods, after disconnecting the crossheads, can be lowered into pits sunk into the foundation, which are ordinarily kept covered by caps, and may then be drawn up on one side of the pillar heads and removed. The supply of steam for all the cylinders is regulated by means of double-beat valves fitted with Collmann's oil dashpots of the newly patented type, mounted in lateral extensions of the cylinders, situated in the rear in the case of the high-pressure and intermediate cylinders, and at the sides in the case of the low-pressure cylinders. The valves are actuated by a shaft behind the low-pressure cylinders resting on six bracket bearings and carrying the whole of the eccentrics. The motion is transmitted from the crankshafts by means of bevel-wheel gearing through an intermediate shaft sloping upwards between the pillars



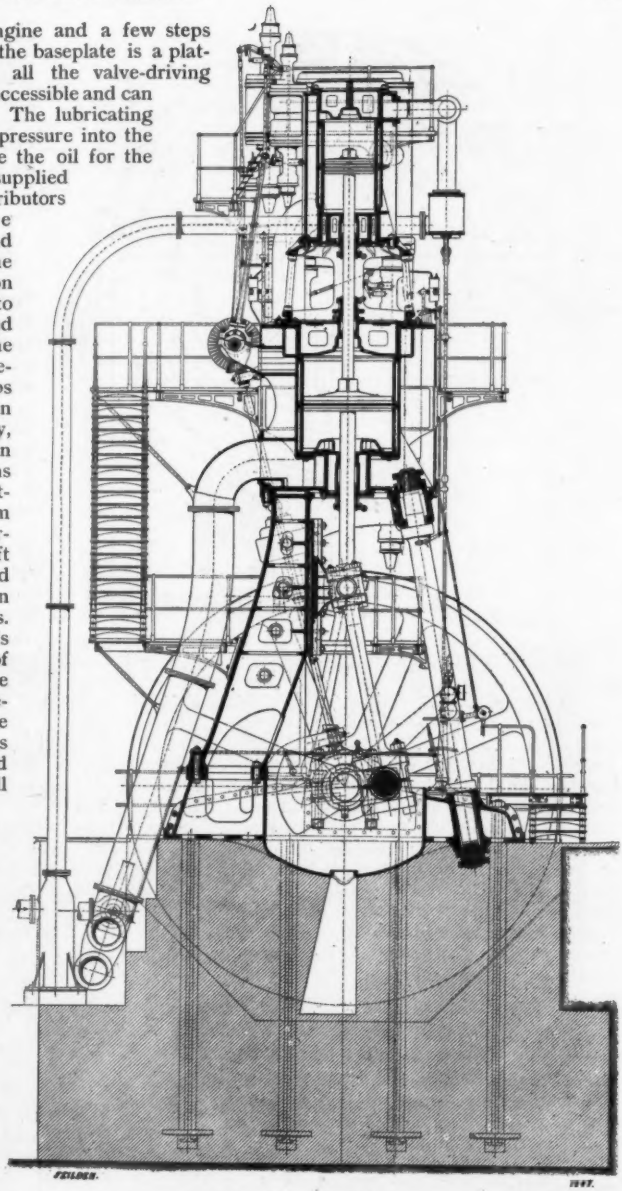
PARIS EXHIBITION: 2,500 H.P. TRIPLE EXPANSION ENGINE BY A. BORSIG, BERLIN.



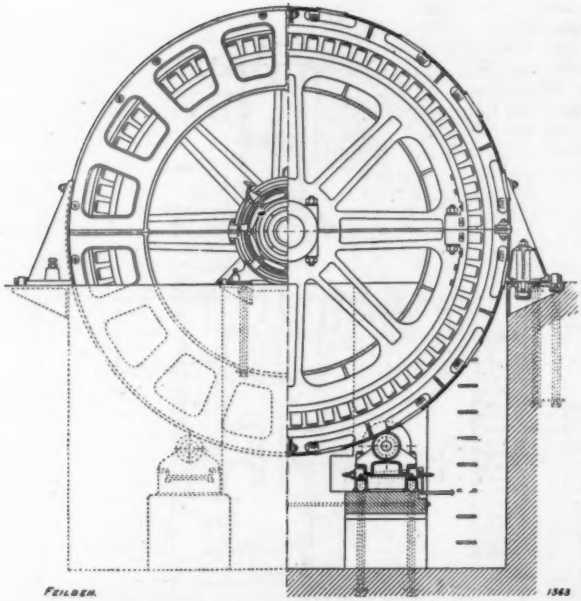
PARIS EXHIBITION:
2500 H.P. TRIPLE EXPANSION BORSIG ENGINE. — LONGITUDINAL SECTIONAL ELEVATION.

and carrying the spring-loaded pendulum governors. The admission and exhaust valves of the four cylinders are worked by slipgear; the high-pressure valve is directly controlled by the governor, while the other valves are actuated by means of fixed detents, which, however, are adjustable by hand. The oil dashpots peculiar to the new Collmann valve motion can be so easily adjusted that the closing of the valves takes place almost without any noise. On the regulating device for the high-pressure and intermediate cylinders the admission valve aud the corresponding exhaust valve are actuated together from the same eccentric, while each of the low-pressure cylinder valves is worked separately by its own eccentric. The number of revolutions of the engine can be altered while the engine is running by means of a hand-wheel acting on a spring in the dashpot box of the governor. The masses of the rotating rods are compensated by counterpoises screwed to the cranks. The connecting rods and cross-heads are of the newest pattern and similar to those of the great marine engines, and the two piston rods on each side are made of one piece.

In front of the engine and a few steps above the level of the baseplate is a platform from which all the valve-driving gear, &c., is readily accessible and can be easily managed. The lubricating oil is forced under pressure into the stuffing boxes, while the oil for the rods and bearings is supplied from two oil distributors mounted on the second platform, and is delivered to the latter by gravitation from a receptacle into which it is pumped from a tank in the basement by a force-pump. The air pumps are fitted with piston and head valves only, there being no suction valves. The pistons are driven by connecting rods leading from either end of an air-pump lever, the shaft of which is mounted on bearings resting on top of the air pumps. This air pump lever is driven at the end of the pumps nearest the engine by the before-mentioned disc on the crank-shaft by means of another lever and intermediate rod. All the bearings and journals of the condensing plant are lubricated by an oil distributor mounted on a cast iron column set in the floor in front of the crank-shaft. The steampipe leads from the pipeway in the rear of the engine to the main throttle valve situated between the high-pressure and intermediate cylinder, which is connected by means of a short pipe with the front



PARIS EXHIBITION :
2500 H P. TRIPLE EXPANSION BORSIG ENGINE.—TRANSVERSE SECTIONAL ELEVATION.



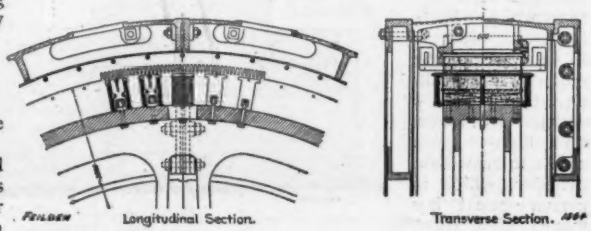
PARIS EXHIBITION: SIEMENS AND HALSKE 2000 K.W. ALTERNATOR, SIDE ELEVATION.

of the high-pressure cylinder. From this latter the steam passes through a vertical copper pipe into the intermediate cylinder and thence into a cast iron box, from which it enters into the two low-pressure cylinders. From each of these exhaust pipes lead along the pillars downwards to the two air-pumps, the waterspray cocks being placed at the lower end of these pipes below the floor. The main object pursued in designing this engine has been to render its supervision easy, and to make it so simple in construction as to facilitate its management without reducing its high efficiency. By means of the four superimposed platforms and the stairs leading to them all portions of the engine can be easily reached.

Although, as stated above, its normal speed is 90 revolutions per minute, at the Exhibition this speed is reduced to 83½ revolutions, and the normal boiler pressure is lowered correspondingly from 14 atmospheres (199·1 lb. per square inch) to 9·5 atmospheres (135·1 lb. per square inch).

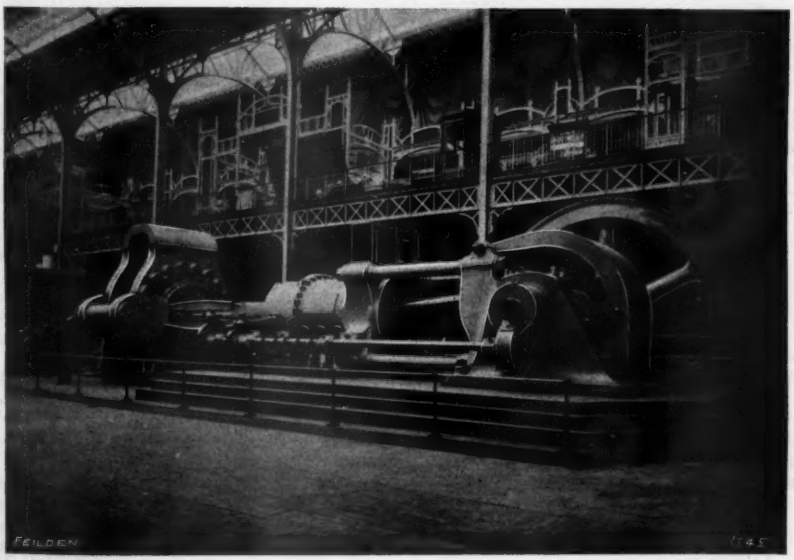
THE SIEMENS-HALSKE ALTERNATING CURRENT DYNAMOS.

As above stated, the Borsig engine in the Paris Exhibition is direct-coupled with a Siemens-Halske alternator, which, at a speed of 83½ revolutions, is calculated to furnish a current of 2,200 volts at 50 alternations per second, and can develop, with an outer resistance free from induction, a maximum power of 2,000 kilowatts. The general principle of construction selected is that of stationary armature, with a field-magnet rotating inside of it. The field-magnet system consists of a divided cast iron rim (*vide* Figs.), connected with the hub by cast spokes, and keyed direct on to the extension of the shaft of the engine. The poles are made of cast iron sheets held together by three bolts and a steel bar of square section, which contains the nuts for the screws which fasten, from the inside, the poles to the cast-iron rim. The tangential force is taken up by a piece mounted on the poles and engaging in a corresponding groove in the rim. The winding of the field-magnets

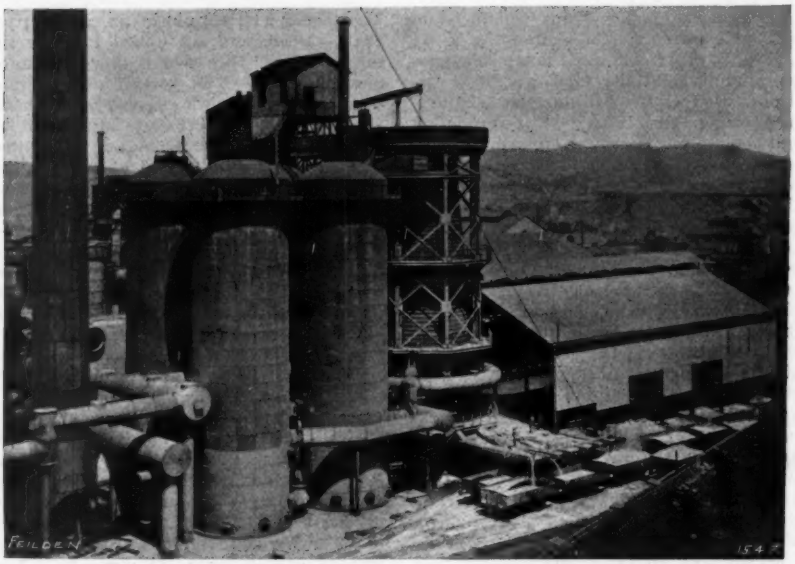


SIEMENS AND HALSKE ALTERNATOR, DETAILS OF ARMATURE AND FIELD MAGNETS.

consists of flat copper bands wound edgewise, and having a cross-section of 4 × 23 mm. (0·15 in. × 0·80 in.) Each pole carries 40 windings, and the total weight of the copper used for the field-magnet windings is 4,000 kg. (78·4 cwts.) For ventilation and cooling purposes the copper winding is, at each of the end faces, carried over hollow bronze castings. This permits the air, while the magnet is rotating, to pass radially through the hollow spaces, and to carry off the heat developed. For the same purpose the core of the field-magnets contains a slot, which permits the air freely to circulate and to be constantly renewed. At the most, 210 volts are required to excite the field-magnets, to which corresponds about an equal number of ampères, since the total resistance of the field-magnets is approximately 1 ohm, while the mean expenditure of energy for the excitation is 21,000 watts, the maximum being 42,500 watts. The outer, or stationary, part of the alternator consists of two supporting rims, so chosen that no important deflection, or alteration of form, can take place, each rim consisting of an inner and an outer ring, joined together by strong radial spokes. They are placed upright in an exactly parallel position, and are joined together by the armature, with which they constitute one solid piece. Of interest is the device by means of which the constructors have provided for the necessary adjustment of the armature and the placing of the centre in a correct position. For this purpose the outside of the rims, which are turned smooth, rest upon two rollers, which can be raised or lowered simultaneously, in which case a vertical displacement of the structure resting on them takes place; or one only may be raised or lowered, or while one is raised the other may be lowered; in either of which cases a horizontal displacement occurs. In this way the two parts of the dynamo can be exactly centred at any time. In order, however, to prevent a displacement when the correct centre has been found and the dynamo is doing work, the armature structure is bolted to two lateral supports, which also take up any strains in the direction of the engine shaft. The armature nucleus situated between the above-mentioned rims consists, as stated already, of iron sheets 0·5 mm. ($\frac{1}{50}$ in.) in thickness, held together and supported by



PARIS EXHIBITION: GAS ENGINE AND BLOWING APPARATUS, DELAMARE-DEBOUTEVILLE AND COCKERILL SYSTEM.



BLAST FURNACES OF THE SOCIETE COCKERILL, THE WASTE GASES FROM WHICH WERE USED IN THE TRIALS OF THE 500-H.P. ENGINE.

suitable castings. This armature, it may be stated, as well as the outside rims, are made of four parts. For the reception of the copper windings, the armature is provided with 648 grooves, 13 mm. (0·51 in.) in width and 55 mm. (2·2 in.) in depth, into each of which is inserted a copper rod having a cross-section of 7 × 44 mm. (0·3 in. × 1·7 in). Moreover, the form of these grooves is such as to permit, after the placing of the copper rods, the insertion of insulating covers of mica, which are packed closely around the rods. The total weight of the copper used in the armature is 2·400 kg. (47 cwts); the total resistance of the windings, when warm, amounts to 0·057 ohm, and the total heating by the current represents 15 kilowatts. The exciter dynamo, an eight-pole continuous-current dynamo, wound in series and developing 45 kilowatts at 210 volts, is of the external pole type with a drum armature.

2500 H.P. TRIPLE EXPANSION ENGINE BY MESSRS. WILLANS AND ROBINSON, Ltd.

Among the many stationary engines is the subject of our special plate, a triple expansion engine by Messrs. Willans and Robinson, of Rugby. The cylinders are of 49 in., 30-$\frac{5}{8}$ in., and 18$\frac{7}{8}$ in. diameter respectively, with a stroke of 23$\frac{5}{8}$ in. With a pressure of 150 lbs. per square inch, it is capable of developing 2,500 h.p. at a speed of 200 revolutions per minute.

Some idea of its enormous proportions may be gathered from the following dimensions.

The crank shaft, together with the crank pins and eccentrics, is a solid forging, weighing about 12 tons, and with a diameter of 14$\frac{1}{2}$ in. at the journals, which are four in number. The bearings are of cast iron lined with white metal, and have a total length of 10 ft. 3$\frac{1}{4}$ in.

The bed plate, which is in halves, weighs 30 tons, and is bolted together longitudinally down the centre line.

The upper and lower portions of the crank chamber are also divided, which enables the crank-shaft, cross-heads, and connecting rods, to be easily withdrawn. The exhaust chamber is in one piece, and the exhaust is carried into a jet condenser supplied by the Worthington Pump and Engine Co.

A large coupling disc is attached, which is also used for the purpose of starting the engine, by barring round.

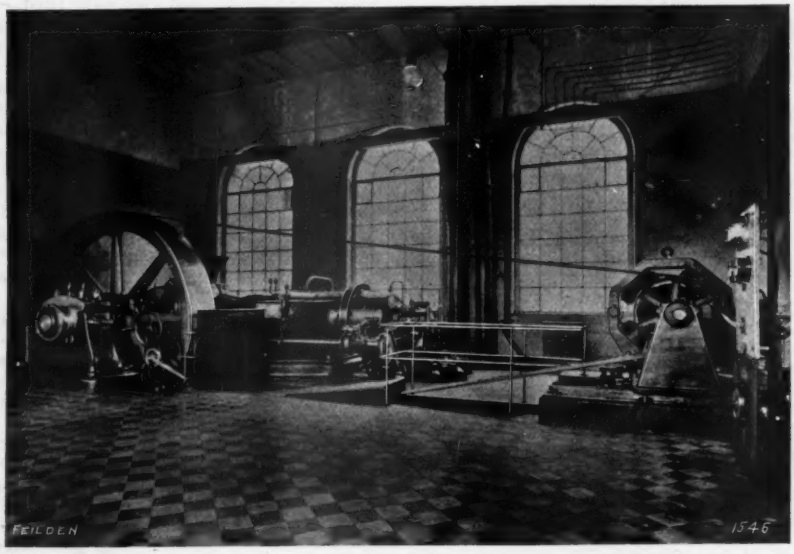
The fly-wheel, as in similar installations, is formed by the armature of the dynamo, which is of the multipolar type, and supplied by Messrs. Siemens Bros. & Co.

The governor is of centrifugal pattern, driven by screw gearing on the crank-shaft, a method adopted by Messrs. Willans and Robinson in all their larger engines.

The total weight of the engine is about 120 tons, and for one of such power, leviathan gas engine of Messrs. Cockerill's, Seraning, Belgium, and which was made to the designs, and under the supervision of Mon. C. Delamare-Debouteville.

The following is an account, together with the trials and installation connected with the same.

Situated in a prominent part of the Exhibition, its enormous size and pronounced type attract a large number of spectators, who express some astonishment at the almost noiseless working and the rapid revolutions of the immense fly-wheel.



200-H.P. GAS ENGINE DRIVING A DYNAMO. DELAMARE-DEBOUTEVILLE AND COCKERILL SYSTEM.

occupies a comparatively small area, a floor space of 31 ft. by 11 ft. 1 in. giving ample accommodation.

At the time of leaving, the erection of this very interesting exhibit was not completed, consequently we were denied the pleasure of seeing it at work.

Two other engines of the same size are in course of construction for the Glasgow Corporation.

THE COCKERILL GAS ENGINE.

Another of the most interesting and impressive of the engineering exhibits is the

The engine, together with the blowing apparatus, weighs about 158 tons, of which 33 tons represents the weight of the fly-wheel alone, the whole resting on a concrete foundation.

Some idea may be formed of its proportions from the illustration and from the following dimensions :—

GAS ENGINE.

Diameter of Cylinder	51·1875 in.
Stroke of Piston	55·125 „
Diameter of Piston Rod	9·6 „
Diameter of Crank Shaft	18·1 „
Height above floor	13 ft. 1½ „
Length over all	36 ft. 1½ „
Width over all	19 ft. 8½ „
Total Weight	127 Tons.

BLOWING APPARATUS.

Diameter of Cylinder	67·24 in.
Stroke of Piston	55·125 "
Diameter of Piston Rod	9·6 "
Height above floor	13 ft. 1½ "
Length over all	18 ft. 3 "
Width over all	11 ft. 5½ "
Total Weight	31 Tons.

GAS AND BLOWING ENGINES CONNECTED.

Height above floor	13 ft. 1½ in.
Length over all	54 ft. 1½ "
Width over all	19 ft. 8½ "
Total Weight	158 Tons.

The whole of the parts are highly finished, and the castings are excellent examples of iron-founding.

The design has been well worked out, there being a complete absence of superfluous metal, every portion has been well studied ; in brief, it is a high tribute to every branch of engineering.

In connection with this remarkable engine, a series of very exhaustive trials were made at the workshops of the Société Cockerill, at Belgium, during the latter part of March last before a numerous body of savants, professional engineers, and technical experts.

The engine used in connection with the trials is the first of the single-cylinder type of 500 h.p., and was supplied from the gases generated in the blast furnaces of the Company.

The blowing apparatus is also the first of this type expressly constructed to meet the conditions of this engine.

A reference to the given dimensions will give some idea of the large proportions of the engine, whilst the illustrations of the same, and that of the furnaces, will convey to the reader the style of design, and the general arrangement.

The details of the trials are as follows :—On March 20th last, the engine was detached from the blowing apparatus, and the shaft connected by means of muff couplings to an extended shaft carrying a dynamometrical brake ; the object of the trial being to determine the efficiency, power, and consumption.

The following day the shaft of the brake was disconnected and the blowing apparatus attached to the engine, the furnaces being fed with compressed air.

This day's trial gave the available power, and the total production of the installation, also the quantity of gas consumed for a fixed amount of work, and methods were adopted for obtaining the thermal efficiency of the engine and the calorific value of the gas.

During the trials, the gas used was generated in the five furnaces illustrated, four of which are 60 ft high, and the other 79 ft., the output of the smaller ones averaging from 85 to 90 tons, and the largest about 210 tons of pig-iron per day when in full work.

On the previous day the furnaces were producing Bessemer steel, with a very hot and basic slag, with gases which were not easily combustible in the boiler fires and hot air apparatus.

In the afternoon the slag became less basic, and the quality of the gas a little better, consequent upon a stronger blast.

On March 21st the smaller furnaces were still engaged on Bessemer steel, whilst the largest was employed for refining purposes. The slag became more acid, but it was not until the next day that a distinct improvement in the gas took place, so that during the time of the trials the engine was only supplied with that of ordinary quality.

The gases are passed through chambers which free them from impurities, and during the passage are subjected to jets of water thrown by Korting injectors, which has the effect of increasing the density of the gas.

Arrangements were made for conveying the gases from the furnaces to the engine by the same passage as that used when firing the boilers—*i.e.*, one leading from a gasometer with a capacity of 300 cubic metres=10,594·7 cubic ft.

This apparatus was the same as used in the trials of 1898 on an engine of 180 h.p.

The quantity of gas consumed by this engine was much more than that of 1898, and the time necessary to empty the gasometer was much shorter. The gasometer could only feed the engine for ten minutes, whilst it took about twenty minutes to fill it by means of a rotary exhauster worked by an electric motor.

The receiver could not be completely emptied, so that the trial could only last over a period of about seven minutes, but the number of tests were sufficient to deduce satisfactory averages and prove if the rule held good by noting the consumption of gas supplied from another source for the additional three minutes, thus affording an opportunity of correcting any errors where they would have been most likely to occur. A special apparatus was used for measuring the quantity of gas supplied to the engine, and readings taken

TABLE No. 1.—Trial of March 20th, 1900, with Load on Brake.

Number of Trial.	Time, p.m.	Average height of Diagrams in millimetres.	Number of Admissions per minute.	Indicated Horse-power.	Tangential Brake effort in lbs.	Number of Revolutions per minute.	Brake Horse-power.	Percentage of Organic Production.	Consumption of Gas per minute in cubic feet at a temperature and pressure and zero Centigrade.	Consumption of Gas per hour in cubic feet. Indicated Horse-power.	Consumption of Gas per hour in cubic feet. Brake Horse.	Consumption of Water. B.H.P. Hour. Gallons to Cylinder.	Consumption of Water. B.H.P. Hour. Gallons to Piston.	Average Temperature in Cylinder. Degrees Centigrade. Entrance.	Average Temperature in Cylinder. Degrees Centigrade. Exit.	Average Temperature of Gases. Degrees Centigrade. Entrance.	Average Temperature of Gases. Degrees Centigrade. Exit.
1	1·24	7·10	41·50	792·61	6375·84	94·17	574·40	72·47	1132·58	85·74	118·3	—	—	—	—	—	—
2	2·12	7·07	43·50	827·88	6342·54	97·50	596·60	71·46	1236·76	89·50	125·44	—	—	—	—	—	—
3	4·23	6·91	42·27	786·05	6386·94	93·33	570·26	72·54	1184·85	90·40	124·66	—	—	—	—	—	—
4	4·52	6·96	40·93	766·75	6375·84	91·93	560·82	73·14	1164·00	91·11	124·55	—	—	—	—	—	—
5	5·21	6·93	41·60	776·17	6327·00	93·92	568·47	73·24	1195·80	92·24	126·21	—	—	—	—	—	—
6	5·51	6·64	46·22	825·81	7516·92	93·20	670·02	81·12	1244·88	90·40	113·45	—	—	—	—	—	—
7	Average of 5 first numbers in each column.	6·99	41·96	789·89	6361·63	94·17	573·11	72·56	1182·94	89·84	123·81	—	—	—	—	—	—
8	Average calculated on the total duration of first 5 trials.	6·97	41·90	786·16	6369·18	94·37	575·00	73·14	1182·94	90·26	123·07	12·49	2·79	7·86	33·17	9·0	508·5

TABLE No. 2.—Trials of March 21, 1900. Gas Engine connected to Blowing Cylinder.

Number of Trial.	Time. A.M.	Average height of diagrams in mm.	No. of admissions per minute.	Indicated Horse-power.	Average height of diagrams of blowing cylinder in mm.	Average number of strokes of blowing piston per minute.	Horse-power of air blown.	Average pressure of air in mm.	Percentage of organic production.	Consumption of gas per min. in cubic ft. at 32 deg. Fah., pressure and zero Centigrade.	Consumption of gas per hour in cubic ft. for I.H.P.	Consumption of gas per hour in cubic ft. for B.H.P.	Consumption of water in gallons. Cylndr.	Consumption of water in gallons. Piston.	Average temperature of water in degrees Centigrade. Entrance to cylinder.	Average temperature of water in degrees Centigrade. Exit from cylinder.	Average temperature of gas in degrees Cent. Etrnce.	Average temperature of gas in degrees Cent. Exit.	Average temperature of air. Entrance to air cylinder.	Average temperature of air. Exit from air cylinder.
1	10·17	7·89	34·27	727·35	26·30	164·6	522·60	392	71·85	988·26	82·32	114·60	—	—	7·75	36·1	8·0	499	—	—
2	10·44	7·74	37·12	772·86	28·20	170·6	580·67	395	75·13	1042·14	80·90	107·67	—	—	7·70	34·2	8·0	493	—	—
3	11·13	7·72	37·47	778·13	28·20	170·0	578·63	404	74·36	1059·80	80·34	109·86	—	—	7·60	35·3	8·1	487	—	—
4	11·44	7·76	35·47	740·41	28·90	164·7	574·51	404	77·59	1029·42	82·92	107·50	—	—	7·65	34·8	8·4	478	—	—
5	12·16	7·12	37·20	712·49	27·25	169·3	556·84	388	78·15	1024·62	86·27	110·39	—	—	7·75	37·1	8·4	486	—	—
AVERAGES		7·64	36·30	746·24	27·77	167·8	562·65	396·6	75·41	1028·84	82·55	110·00	11·39	2·95	7·69	35·5	8·18	488·6	15·2	62·0
	P.M.								SECOND TRIAL.											
6	2·4	7·06	46·00	873·59	33·45	184·00	743·07	451	85·06	1191·84	81·86	96·23	—	—	8·10	40·0	9·6	555	—	64·0
7	2·32	7·00	46·00	866·18	32·40	184·00	719·50	450	83·07	1195·51	82·81	99·69	—	—	8·10	39·8	9·7	550	—	64·0
8	3·3	7·26	46·25	903·22	32·25	185·00	720·13	453	79·73	1224·90	81·36	102·06	—	—	8·15	38·3	10·1	545	—	65·0
9	3·33	7·01	47·20	890·05	31·75	188·80	723·52	448	81·29	1241·42	83·66	102·94	—	—	8·12	38·2	10·0	545	—	65·0
10	4·7	7·10	47·09	899·37	31·65	188·40	719·73	449	80·03	1235·91	82·46	103·01	—	—	8·15	38·8	10·0	540	17·0	65·0
AVERAGES		7·08	46·50	886·28	32·30	186·04	725·19	450·2	81·83	1217·91	82·43	100·78	8·80	2·26	8·12	39·0	9·88	547	—	64·6

every five minutes and temperature of exhaust every quarter hour, the latter only being possible owing to the recording instrument being located under the engine bed where the heat was very great. A practical method for measuring the consumption of gas was adopted by opening the valve leading from the receiver the moment it had obtained its full capacity, which instantly released a full volume. The calorific value of the gas was determined by means of a Junker calorimeter and corrected by other methods. The work developed in the cylinder was periodically obtained by means of a Crosby indicator, which was tested for accuracy before and after use.

The brake horse-power was measured by a dynamometer consisting of a pulley 3·01 metres (9 ft. 7 in.) diameter, supporting three ropes on its upper half held together by clamps, the ends terminating in a spring balance and weight platform.

The shackles, weights, &c., were carefully measured before the trial, and provision made for cooling the pulley by a constant jet of water, the necessary readings from the same being taken every five minutes. This brake is supposed to be the largest yet used, and the satisfactory way in which it worked would justify its application to a heavier test.

The governor acts by regulating the admission of gas, and a counting arrangement is fixed for obtaining the number of admissions per minute, and a similar one for the revolutions.

The air pressure was also taken on each face of the blowing piston by Thomson indicators, and that of the outlet by mercurial gauge.

A recorder was used for tracing the rotation of engine shaft and pressure of air blown during the trials.

The cylinder and piston being water-jacketed, the temperature and volume of the circulating water was taken every five minutes.

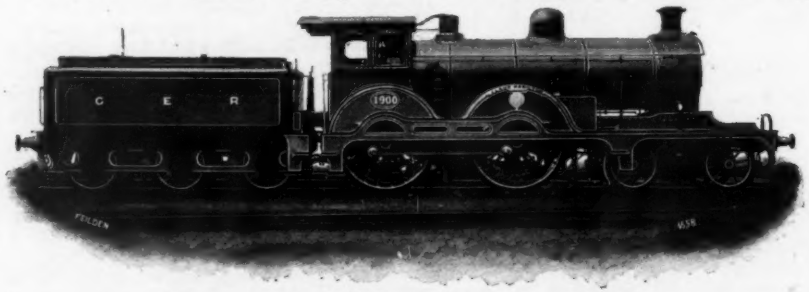
In the trials made with the brake and the blowing cylinder various modifications were adopted in order to obtain correct observations, and the averages deduced from the same have been arranged in Tables No. 1 and 2, and in connection with the above are also the following percentages :—

	Junker Calo. Per ct.	M. Witz's Test. Per ct.
Heat Converted in Work ...	30·66	27·11
„ Carried away by the Water	54·90	48·54
„ „ „ „ gases and losses ...	14·44	24·35

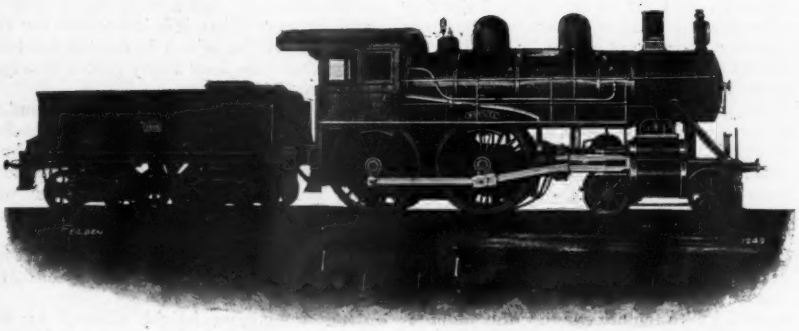
As the combustion in the cylinder was not made at constant pressure or constant volume, the calorific schedule was approximately as follows :—

	Per ct.
Heat Converted in Work in the Cylinder ...	28
„ Given up to Circulating Water... ...	52
„ Carried away by Gases and Losses ...	20

An exhaustive report was drawn up by Professor A. Witz, of Lille University, on the trials of July, 1898, and he states that the small amount of gas consumed was considerably below what had been anticipated, as only 3·329 cubic metres=117·6 cubic feet per horse-hour—had been used. This represents an enormous saving over the amount necessary to produce an equal force by a steam engine. The experiments of March 20 and 21, 1900, established an even better record, and proved that Mon. Delamare-Debouteville and the Cockerill's Society's engineers had made a record which had exceeded any previous results, as the consumption per horse-hour had



PARIS EXHIBITION :
GREAT EASTERN RAILWAY FOUR-WHEELS-COUPLED BOGIE EXPRESS ENGINE NO. 1900, "CLAUDE HAMILTON."



THE PARIS EXHIBITION: COMPOUND EXPRESS PASSENGER ENGINE, BUILT FOR THE FRENCH STATE RAILWAYS BY THE BALDWIN LOCOMOTIVE WORKS.

fallen to 3·156 cubic metres=111·4 cubic feet on the last trial of March 20, decreasing on the morning of March 21 to 3·113 cubic metres=109·9 cubic feet, and retaining six admissions on 84 revolutions=7 per cent.

For several consecutive hours of the afternoon of March 21 the engine developed nearly 900 indicated horse-power, with a consumption of only 2·853 cubic metres=100·7 cubic feet per horse-hour—from a calorific power at constant volume.

This excellent result was obtained with the engine fully charged, and as the running has been continued for a much longer period, it does not seem possible to improve upon the magnificent attainments. It indicates in a very pronounced manner the important progress made in the utilisation of the waste gases of blast furnaces and marks a great industrial advance, as it conclusively shows that it is possible to work a large engine of this type on strictly economical lines.

The trial of 1898 has proved that, by the utilisation of the blast furnace gas on an engine of the Debouttéville and Cockerill system, it was possible to provide additional power for other services or to run any other part of the works annexed to the furnaces. It is therefore quite within the bounds of reason—in fact, it may be practically demonstrated—that it is possible to disconnect the gas service which feeds the boilers, and carry it direct to the engine, thus creating a blast which eventually develops a further supply of gas which is in excess of what is required by the engine, and therefore the only intermediate factor is the fuel used in the furnaces.

Perhaps one of the chief characteristics in the application of these gases is the utilisation of them in an almost crude form, without having recourse to any expensive apparatus for cleansing, so it may be said no trouble is to be anticipated in regard to dust or other impurities.

GREAT EASTERN RAILWAY FOUR-WHEELS-COUPLED BOGIE EXPRESS ENGINE.

This engine is fitted with liquid fuel burners. The fuel is heated by the exhaust steam of the Westinghouse pump or, at will, by live steam from the boiler; this, in combination with an independently regulated supply of both air and liquid fuel to the burners, enables engines to be worked either lightly or heavily with complete combustion and entire absence of smoke. There is a battery of tubes through which the air is heated by the waste gases before being supplied to the burners. Coal can be burnt instead of, or in conjunction with, liquid fuel without any alteration.

The Westinghouse pump provides compressed air for all purposes. The foot-plate is cast hollow, and is utilised as a reservoir for the compressed air. The cock for supplying steam to the pump automatically closes or opens when the air pressure reaches maximum or minimum.

The engine can be reversed by hand or compressed air. One end of the reversing cylinder is always open to the main brake

reservoir, and by means of a balancing valve the other end is always automatically kept at a pressure of 30 lbs. less than in the main brake reservoir. The motion being balanced, a small frictional clutch will lock it in any position. Should anything go wrong with the air-locking arrangement, mechanical locking takes place automatically. The driver can use the air-lever or hand-wheel at will, without putting anything in or out of gear ; when reversing by air the hand-wheel remains stationary. Usually it is difficult with a power reversing gear to operate it when the engine is not in steam ; in the present engine it can be operated with facility whether the engine is in steam or "dead."

The tender is fitted with apparatus for picking up water en route, the scoop being operated by compressed air.

Flanged plates are extensively used in lieu of angles, as in the smokebox front plate, the ring joining boiler barrel to front tube plate, and the dished plates by the front bogie wheels, these latter allowing the main engine frames to be perfectly straight and in one piece, neither bolting, joggling nor bending being required. This is unique in a bogie engine and gives strength and rigidity. It also allows of a maximum space for cylinders.

Firebox stays are of Stone's patent bronze and are made specially flexible by longitudinal saw-cuts. They are pitched diagonally instead of vertically and horizontally, thereby increasing the metal along the line of first fracture by over 40%; this, in conjunction with triple rivetted longitudinal joints having an efficiency of 90% of that of the solid plate, allows of much lighter plates being used in the construction of the boiler.

A Bourdon gauge attached to a tube working somewhat after the manner of a barometer enables the driver without leaving the foot-plate to know what reserve of water he has, although the well of the tender is some three feet below the footboard.

The slide valves are balanced by strips somewhat resembling Richardson's strips, but by a new arrangement are rendered steam tight between the strips and the valve, and between the strips themselves, no matter how unevenly the strips or valve may wear or expand by heat.

Exhaust steam is utilised for supplying the boiler with water.

The tyres are fastened to the wheels in such a manner that it is impossible for the tyre to leave the wheel in case of fracture, no matter into how many pieces the tyre may break.

The arrangement of valve chests underneath allows large cylinders, 19 inches diameter, to be combined with a minimum distance from centre to centre of cylinders, and unusually roomy passages for the exhaust steam and long bearings to crank axle may be retained.

The tubes are of large diameter and the firebox is shallow, thus giving very effective heating surface.

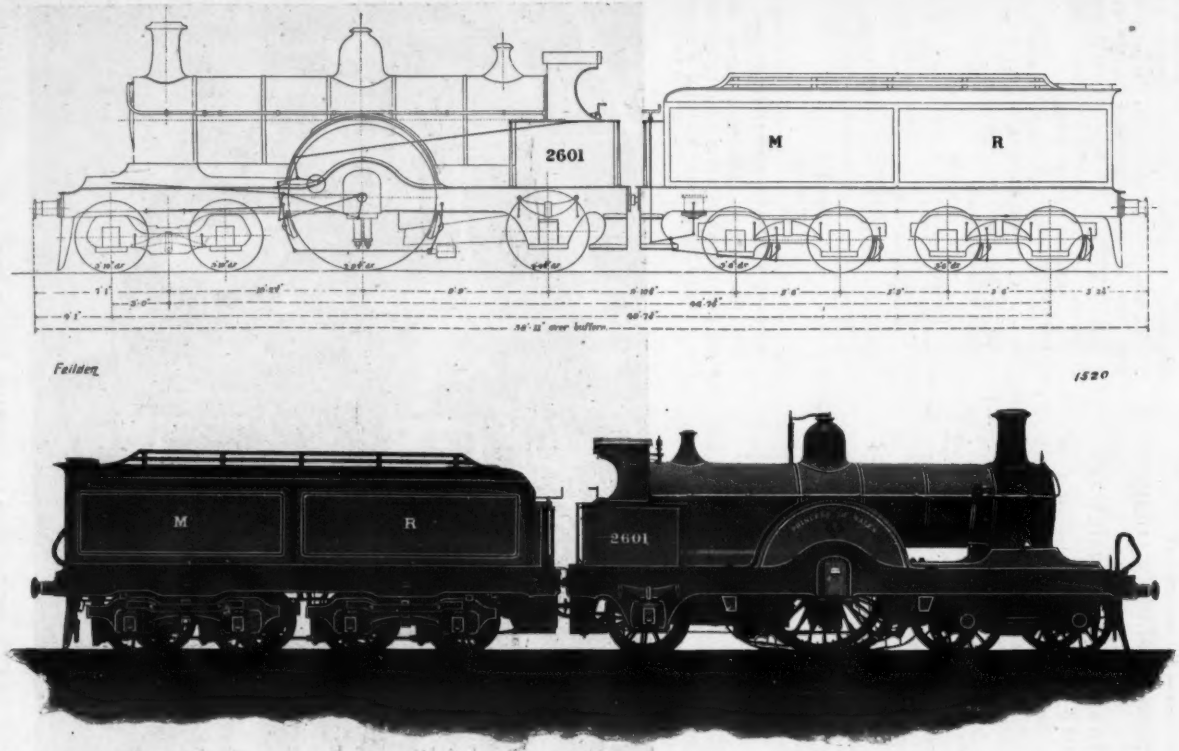
The maximum height allowed by the construction gauge of the Great Eastern Railway is 12 feet 11 inches from rail level.

The leading dimensions of the engine are as follows :—

Cylinders			
Diameter			19 in.
Stroke			26 „
Connecting rod centres			7 ft. 7½ „
Wheels			
Diameter of driving and trailing			7 ft.
„ „ bogie			3 ft. 9 „
Wheel-base			
Centre of bogie to centre of driving wheels			11 ft. 3 „
Centre of driving to centre of trailing			9 ft.
Total			23 ft. 6 „
Frames			
Total length			30 ft. 7 „
Distance between			4 ft. 1½ „
Thickness			1 „
Boiler			
Diameter outside			4 ft. 9 „
Length of barrel			11 ft. 9 „
Height of centre line of boiler from rail level			8 ft. 3 „
Length of firebox outside			7 ft.
Width „ „			4 ft. ½ „
Number of tubes			274
Diameter of tubes outside			1¾ „
Working pressure			180 lbs. per sq. in.
Heating surface			
Tubes			1516·5 sq. ft.
Firebox			114 „ „
Total			1630·5 „ „
Firegrate area			21·3 „ „
Weight of engine in working order	tons.	cwt.	qrs.
On driving wheels	16	12	1
„ trailing „	16	12	1
„ bogie „	17	4	0
Total	50	8	2
Weight of tender in working order	35	1	0
Wheel-base of tender	12 ft.		
Diameter of tender wheels	4 ft. 1 in.		
Capacity of tender			
Water	2,800 gallons		
Oil	720 „		
Coal	30 cwt.		

THE BALDWIN LOCOMOTIVE CO.'S EXHIBIT.

The illustration on page 199 shows the compound express passenger locomotive built for the French State Railways by the Baldwin Locomotive Works. The French State Railways have already had five locomotives of this type, and six of similar dimensions, except with single-expansion



THE PARIS EXHIBITION: MIDLAND RAILWAY EXPRESS PASSENGER LOCOMOTIVE NO. 2601, "PRINCESS OF WALES."

cylinders. The following are the general dimensions of the locomotive.

EXPRESS PASSENGER LOCOMOTIVE FOR THE FRENCH STATE RAILWAYS.

CLASS 8-20/38 C. GAUGE, 4′ 9½″.

GENERAL DIMENSIONS.

CYLINDERS.

Diameter (High pressure)	13 in.
„ (Low pressure)	22 „
Stroke	26 „
Valve	Balanced Piston

BOILER.

Diameter	56½ in.
Thickness of Sheets	13/16 „
Working Pressure	215
Fuel	Soft Coal

FIREBOX.

Material	Copper
Length	88½ in.
Width	41⅜ „
Depth	71½ in. front, 58½ in. back
Thickness of Sheets	Sides ½ in.
„ „	Back ½ „
„ „	Crown ½ „
„ „	Tube ½ & 7/16 „

TUBES.

Number	282
Diameter	2 in.
Length	12 ft. 1 „

HEATING SURFACE.

Firebox	128·4 sq. ft.
Tubes	1764·2 „
Total	1892·6 „
Grate Area	25·58 „

DRIVING WHEELS.

Diameter outside	84¼ in.
Diameter of Centre	78 „
Journals	8×10 „

ENGINE TRUCK WHEELS.

Diameter	36 in.
Journals	6×10 „

WHEEL BASE.

Driving	8 ft. 0 in.
Total Engine	23 „ 6 „
Total Engine and Tender	48 „ 7½ „

WEIGHT.

On Drivers	69,760 lbs.
On Truck	48,225 „
Total Engine	117,985 „
Total Engine and Tender	196,000 „

TENDER.

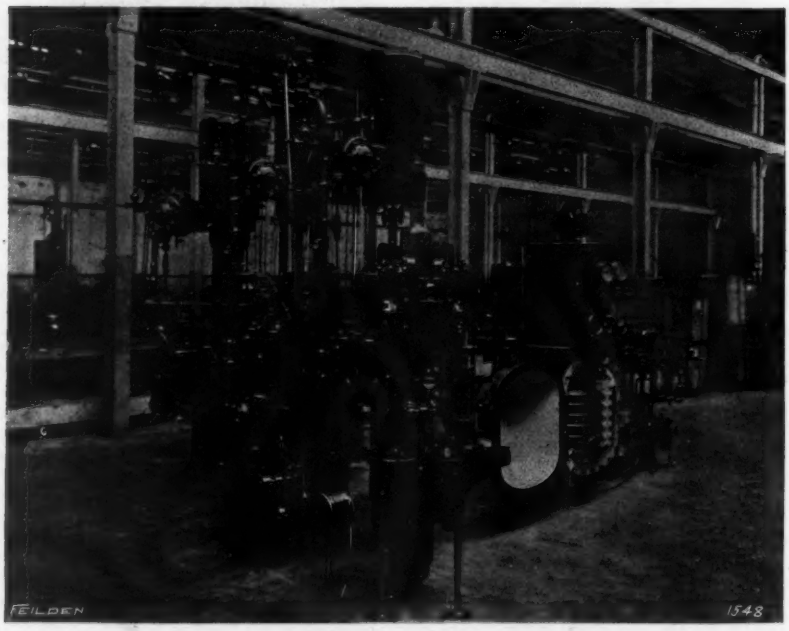
Diameter of Wheels	36½ in.
Journals	4½×8 „
Tank Capacity	3,600 gal.

SERVICE.

Passenger.

MIDLAND RAILWAY LOCOMOTIVE, No. 2601.

This fine express passenger engine, two illustrations of which are given on page 201, was constructed at the Midland Railway



THE PARIS EXHIBITION: GROUP OF PUMPS AND EVAPORATING PLANT, BY MESSRS. G. AND J. WEIR, LTD., GLASGOW.

Company Works, Derby, from the designs of Mr. Samuel W. Johnson, the locomotive superintendent. This machine is the second constructed of a type which has amply demonstrated its capability of fine performances, as will be manifest from the following particulars :—

details of engine and tender are given below :—

CYLINDERS.

Diameter	19½ in.
Stroke	26 „
Length of Port	17⅜ „
Width	1¾ „
Piston Valves, diameter	8 „

PARTICULARS OF PERFORMANCES BY ENGINE No. 2602.

WORKING EXPRESS TRAINS BETWEEN NOTTINGHAM AND LONDON.

ENGINE No. 2602 SAME CLASS AS No. 2601.

Nottingham and London. *Distance 124 miles.*	Coal used per mile. lbs.	Water used. Total gallons.	No. of Vehicles at 12 tons each, including Passengers and Luggage	Mean Weight of Train and Passengers. Tons.	Mean Weight of Engine and Train. Tons.	Mean running speed. Booked. M.P.H.	Mean running speed. Actual. M.P.H.	Starts and stops in the running time. No.	Remarks.
1900.									
April 8.34 a.m. Nottingham to London	28·57	3,050	12·22	146·65	239·80	50·8	51·80	5	Dull, rain at times, slight side wind.
„ 3. 0 p.m. London to Nottingham		3,025	13·25	159·00	250·62	51·0	51·80	4	Showery, rails wet, wind light.
May 10.28 a.m. Nottingham to London	28·37	2,825	10·67	128·15	222·05	52·0	54·75	2	Weather fine, light side wind.
„ 4.55 p.m. London to Nottingham		2,900	12·55	150·68	242·53	50·25	51·90	5	„ „ „ „
„ 8.34 a.m. Nottingham to London	31·40	3,225	10·73	128·80	221·75	50·8	51·30	5	Showery, strong westerly side wind.
„ 2.10 p.m. London to Nottingham		3,375	14·77	177·22	267·70	52·0	52·00	1	Very heavy side wind, west by north. Engine had to be worked heavily.
„ 5.25 a.m. Nottingham to London	29·61	3,200	11·79	141·59	234·44	48·9	50·20	3	Weather fine, light wind.
„ 10.40 a.m. London to Nottingham		3,250	16·80	201·61	292·56	52·0	54·00	1	„ „ „
„ 1.10 p.m. Nottingham to London	35·7	3,375	15·86	190·36	284·29	51·3	51·75	3	Very strong cross wind, east by north.
„ 5.40 p.m. London to Nottingham		3,650	15·71	188·55	280·41	51·7	51·20	3	Stormy, rain in places, gale from north-east. Train electrically lighted ; dynamos driven off carriage axles.

AVERAGE FOR THE FIVE DAYS' WORKING.

Trains.	Miles un. Total.	Time in Steam. Hours.	Coal. Per mile. lbs.	Coal. Per ton mile. lbs.	Coal. Per I.H.P. per hour. lbs.	Water used per lb. of coal. lbs.	No. of Vehicles.	Mean weight of Train and Passengers. Tons.	Mean weight of Engine and Train. Tons.	Mean speed. Booked. M.P.H.	Mean speed. Actual. M.P.H.
As above ..	1,240	51·75	30·73	0·121	2·9	8·37	13·43	161·26	253·61	51·07	52·07

The consumption includes all coal used from the time of leaving to returning to the Shed, Nottingham. South Yorkshire coal was used in each instance.

The chief rising gradients between London and Nottingham are as follows :—

UP JOURNEY.

24¾ miles, maximum continuous length 5¼ miles . . . . 1 in 200
3 miles . . . . . 1 in 120

DOWN JOURNEY.

4¾ miles 1 in 176·5
4¼ „ 1 in 166
3¼ „ 1 in 200
3¼ miles 1 in 119.
2 „ 1 in 138·5.

The engine has a pair of driving wheels 7 ft. 9½ in. in diameter, driven by cylinders 19½ in. by 26 in. stroke. The unusual size of the latter for inside driving has rendered it necessary to place the valve chests beneath the cylinders, the valves being driven direct from the eccentrics without a working shaft. Some of the principal

Piston Valves, lap	1¼ „
„ „ lead in full gear	¼ „

WHEELS—Cast Steel.

Engine Bogie Wheels	3 ft. 10 in.
Driving „	7 „ 9½ „
Trailing „	4 „ 4½ „
Tender „ „	3 „ 6 „
Thickness of Tyre on tread	3 „

AXLES—Steel.

Journals Engine Bogie	5½ in. diam. × 9 in.
„ driving inside	8½ „ „ × 7½ „

AXLES—Steel.—*Continued.*

Journals driving outside	6½	„	× 9 in.
„ trailing	5½	„	× 9 „
„ Tender Bogie	5½	„	× 9 „
Diam. at centre Engine Bogey			5⅛ „
„ „ Driving			8 „
„ „ Trailing			6½ „
„ „ Tender Bogie			6½ „

BOILER—Steel.

Working Pressure	180 lbs. per sq. in.
Length of Barrel Telescope	10 ft. 6 „
Diam. „ inside	4 „ 1⅛ „
Length of Firebox Shell	8 „ 0 „
Thickness of Barrel Plates	⅝ „
„ Firebox Shell, front plate	½ „
„ Firebox Top, Sides and Back	⅜ „
„ Smoke Box Tube Plate	½ „
Number of Tubes, Copper	228
Diameter „ outside	1¾ in.

FIRE-BOX—Copper.

Length inside at bottom	7 ft. 3⅛ in.
Width „ „	3 „ 4½ „
Thickness of Tube Plate	½ „
„ top, sides, and back	⅜ „

HEATING AND GRATE SURFACES.

Firebox Heating Surface	147 sq. ft.
Tubes „ „	1,070 „
Total	1,217 „
Grate area	24·5 „

WEIGHTS—In Working Order.

	T.	C.	Q.	T.	C.	Q.
Engine—Bogie	16	16	3			
„ Driving	18	10	0			
„ Trailing	14	16	1			
„ Total				50	3	0
Tender—Tank full and 3½ tons coal.						
„ Leading bogie	26	0	0			
„ Trailing „	23	2	1			
„ Total				49	2	1
Engine and Tender, Total				99	5	1

Centre of Boiler from Rails	8 ft. 1 in.
Total length of Engine and Tender over Buffers	58 „ 11 „
Gross Tractive Power	14,803 lbs.
Adhesive Power with steam sanding	18,100 „
Capacity of Tender, water	4,000 galls.
„ „ coal	5 tons.

MESSRS. G. & J. WEIR, LTD., CATHCART, GLASGOW.

This firm is represented by an interesting display of auxiliary machinery specialities. They show a pair of direct acting feed pumps with automatic control gear suitable for 1,600 i.h.p., such as is being fitted in the leading vessels of the Mercantile Marine. They also show various sizes of a differential pump suitable for boiler feeding, either for land or marine work. This is an exceedingly compact and neat pump for moderate sized boiler plants. An example of a standard feed pump for land purposes is also exhibited. This, like the other pumps, is of the vertical direct acting type, and is specially adapted for electric light stations, mills, factories. This firm also shows an example of a high-pressure feed pump, Admiralty type, for watertube or other boilers working at specially high pressures. This pump has been adopted by the British Admiralty, and several foreign navies.

An interesting and instructive item of this exhibit is a complete set of evaporating and distilling plant capable of producing 15 tons of fresh water per day from sea water. It comprises an evaporator, distilling condenser, circulating, feed and fresh water pumps, all of the Admiralty type, and similar to what the firm are supplying to H.M. Navy and various foreign navies. The evaporator is exhibited with the door opened, showing the ease and handiness with which the tube stack can be taken out for cleaning. An evaporator of the Merchant Service type suitable for yachts, etc., is also shown.

THE HARDY PATENT PICK CO., LTD., SHEFFIELD.

This firm have sent a selection of mining, contracting, and quarrying tools. These are shewn on a central pyramidical trophy, the bright steel and vivid colours of the tools being in striking contrast with the black velvet column and its base. Rock and coal boring by hand is represented by a large assortment of machines for holing in the softest material or penetrating hard rock. The well-known "Elliott" and "Ratchett" machines being shewn in position, with every facility for examining methods of working with automatic feed for various degrees of hardness of the rock to be bored.

In order to provide a drill which will penetrate quickly the very hardest known rock, and which could not possibly be attempted by hand-power machines, a departure has been made this year by introducing a pneumatic or steam drill, know as the "Daw" machine. The horse-power expended in this machine can be automatically arranged so that a minimum horse-power is expended when boring in ordinary material, and the quantity of air consumed is in proportion to the rock to be bored; the special feature, however, being an arrangement whereby the machine can be instantaneously made capable, by the operator, of developing a horse-power and speed of boring hitherto unknown. A speed of 1,000 blows per minute can, if necessary, be obtained with a force of 400 to 500 lbs. per blow, and without any liability of striking either the front or back end of the cylinder. The valve arrangement of this machine consists of one piece, a simplification of detail hitherto unknown.

The International Tramways and Light Railways Exhibition:

At the Royal Agricultural Hall, Islington.

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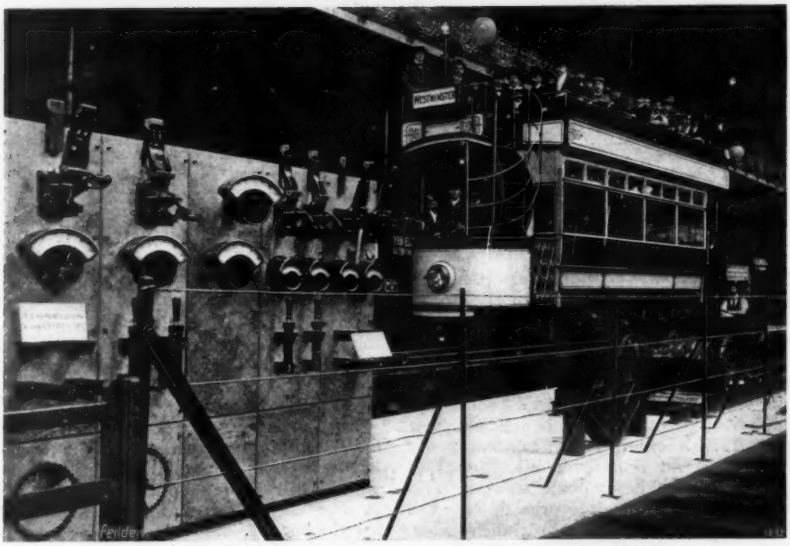
If ever there was a sound reason for inaugurating an exhibition, in this age of exhibitions, this claim can be justly made for the "Tramways and Light Railways Exhibition" which from June 25th to July 4th attracted the attention of London, and which, notwithstanding its short life, will have a permanent and beneficial effect upon British enterprise. London badly needed an *ad oculos* demonstration that electric energy has "come to stay" and the promoters of the enterprise deserve the thanks of all friends of Industrial Progress. The editors of technical journals and of many of the daily papers have been repeating, with almost painful reiteration, that our street locomotion has remained disgracefully behind that of many provincial towns in the United Kingdom—and immensely behind the cities of the United States and the Continent—but all that has been written and spoken on the subject for the last few years could not accomplish what, we believe, will have been accomplished by bringing before the eyes of our local authorities the results of electrical energy as applied to locomotion.

London is awakening and, considering its immense material and intellectual resources, it may yet outrun those to whom it has given so great a start, provided its rulers are in earnest in their wish to profit from the experience of our industrial competitors. The question of "domestic locomotion" is quite as important to the civilised world as the international locomotion which has stamped its character upon the nineteenth century, and nowhere is this problem of urban and suburban traffic a matter of greater concern than in our gigantic metropolis, which is beginning to suffer severely from congestion and shows most dangerous symptoms of overcrowding. For the solution of this problem we find all that is necessary in the invention of the clean, swift and smoothly gliding electric tramway that in so many cities of the world has already rendered travelling a luxury, and solves the question of gradual decentralisation in the most effective manner.

THE WESTINGHOUSE EXHIBIT.

Anybody who may heretofore have doubted the immense superiority of the electric tramway over the old fashioned "bus" which still plays so important a part in the streets of London, would have his doubts dispelled if, after reaching the Agricultural Hall in one of the ordinary conveyances, he had taken a short ride through the building on the elegant Westinghouse tramcar, and looked into the method of propelling and guiding the modern vehicle. The Westinghouse exhibit was in fact a complete and convincing answer to the question as to whether the adoption of electrical locomotion will furnish the means of traffic that the inhabitants of the metropolis require, and will really inaugurate a new era of "domestic locomotion." Visitors pausing before the splendid array of the products of the British Westinghouse Electric and Manufacturing Company—could see almost at a glance the whole system of working an electric railway from the power-house to the moving car.

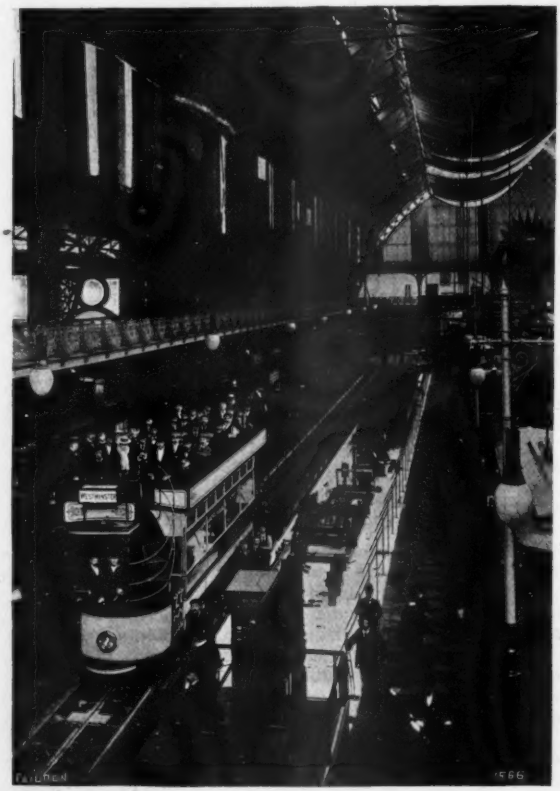
The generating plant, situated in the left hand corner of the hall, consisted of a three cylinder, 13 inches × 14 inches gas engine, rated at 112 b.h.p. when running at 260 revolutions per minute, but having a maximum capacity of 126 b.h.p. when operating with illuminating gas of good average quality. This type of engine is distinguished by a very uniform speed and accuracy as regards governing, and will supplant the steam engine wherever these qualities are of paramount importance, as is notably the case in driving dynamos. In the great works now in course of erection for the



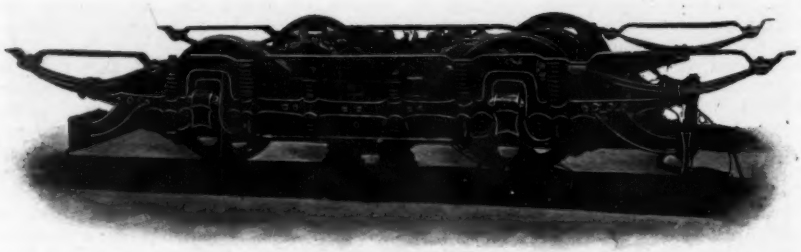
THE BRITISH WESTINGHOUSE COMPANY'S EXHIBIT: THE SWITCHBOARD AND CAR.

Company, at Manchester, a large section will be reserved for the manufacture of this kind of engine, of which the patterns embrace at present engines as small as 10 h.p. and as large as 650 h.p., with a great and increasing number of intermediate sizes; but engines much more powerful than the largest so far constructed are to be built in the near future. The engine in the Tramways and Light Railways Exhibition was shown direct connected to a 75 kilowatt, 500 volt compound-wound engine-type generator of the well-known standard Westinghouse design, and near it was to be seen the elegant switchboard of marble, the four panels being fitted with the usual switches, circuit breakers and other accessories, all of Westinghouse manufacture. The track on which the car was running had a continuous length of 310 feet, extending over the full length of the hall, and was left open for inspection, excepting for a short stretch on either end, paved with wooden blocks, which served to show the appearance that the track has in a real street. As seen through the open portion, the line in the Exhibition, in perfect imitation of a real line of the Westinghouse conduit system, consisted of a series of cast-iron yokes, each cast in one piece, and carefully strengthened by ribs at points where the greatest strain is likely to occur. These yokes, spaced five feet apart, centre to centre, bear the tramrails at their extremities, with the channel rails, conduit section, and automatic switches which characterise the Westinghouse type of line, in the centre. The Westinghouse conduit system is free from all objections urged against the trolley system and is not only reliable, but safe; for in actual practice the conduit, extending between the yokes, is of concrete and encloses two conductors, one for the supply and the other for the return current, and the current cannot run astray and do mischief by corroding gas or water pipes as is the case where other systems exist. Both the lead and the return conductors are isolated from the yokes and earth by means of porcelain insulators fixed to the yokes at suitable points of the track, and the car picks up the current from one conductor and returns it by the other, by means of a so-called contact "plough" which is connected to the car by a suitable insulated connection passing through a narrow open

slot. The most characteristic, however, of the devices, is the division of the conductors into sections, so arranged, that the current passes only through that section over which at the time the car is actually moving. This is effected by means of a simple electro-magnetic switch that acts automatically, and with absolute precision, and is easily accessible for inspection. The division of the track into sections removes one of the great defects of the ordinary systems, namely, the loss of power by leakage. The leakage in the Westinghouse system is a negligible quantity, since it affects only a single section at a given time, *i.e.*, the section through which alone the current is flowing. The automatic switches, by means of which the car charges one section and discharges another, are operated by electro-magnets, and one of the features of the system is that the car furnishes a current of 500 volts from an auxiliary source, which, operating on the electro-magnet closes the switch, and thereby connects the section to the cables. These switches, moreover, are enclosed in water-tight cast-iron castings, so that the possibility of flooding the contacts is avoided. This system of current distribution for electric tramways is applied with equal success by the Westinghouse company to conduit, surface-contact and third-rail installations. The car shown at the Exhibition was one specially designed for metropolitan service and contained all modern appliances which contribute to the comfort and safety of the passengers, together with the ingenious plough which is held in contact with the two conductors in the conduit. The two sides of the "plough" are insulated from each other and connected to a car through a connection—$\frac{5}{8}$ inch wide, made up of two $\frac{1}{16}$ inch plates—which passes through the open spot between the rails. A hinge upon which the plate turns permits the plough to accommodate itself to any curves in the track. The motors, of which there are two on the cars, are of the British Westinghouse No. 49 type, which are four-pole machines with small armatures and light revolving parts. The gear and pinion are composed of cast steel and forged steel respectively and the motors are controlled by the well-known Westinghouse controller. All these details could be fully examined at the Tramways and Light Railways Exhibition and were admired by the experts who saw them. Space does not



THE BRITISH WESTINGHOUSE COMPANY'S EXHIBIT : GENERAL VIEW OF THE CAR & TRACK.

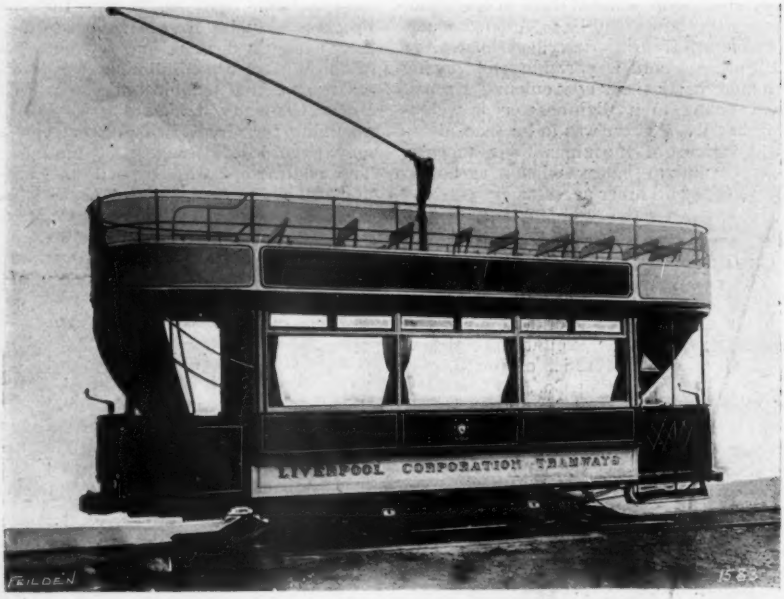


THE BRITISH WESTINGHOUSE COMPANY'S EXHIBIT: TRUCK FITTED WITH NEWELL'S PATENT ELECTRO-MAGNETIC BRAKE.

permit us to go into a more complete description of the Westinghouse exhibits; we will, however, conclude by giving an account of a novelty in the tramcar equipment which represents a very ingenious improvement in the braking arrangement of electric cars, namely the Westinghouse Electro-Magnetic Brake (Newell Patents), which combines the action of an ordinary hand brake with a track brake. The device consists of a horse-shoe electro-magnet, suspended on spiral springs, so that, when not in use, the legs hang directly over the rail, though free to rise clear of any obstruction 3 inches to 4 inches in height. When, however, the brake has to be worked and the magnet is excited by a current passing through its wire-coil, it is attracted vertically down to the rail, which the shoes with which the legs are provided grip, as do the shoes of an ordinary track brake. But there is this considerable difference between the latter and the Newell device that, while in the ordinary track brake the braking effort is obtained at the expense of the car weight, and the pressure of the wheels is lessened, and while the gain effected by the track brake is, therefore, offset to a considerable extent by the loss of the effect of the wheel-rim hand brake, in the Newell brake, by a very simple arrangement of levers connecting the electro-magnetic track brake with the shoes of the wheel-rim brake, the pressure of the shoes on the track increases simultaneously with the pressure on the wheels, and the effective weight on the wheels is not changed by the track brake. An important detail in this arrangement is, that the power for actuating the electro-magnetic brake is derived, not from the main electrical supply, but from the car motors which, for the time being, are converted into generators. An improved form of rheostat, or diverter, having a constant resistance regardless of the heating produced by a continous flow of current, automatically controls the speed according to requirements and adjusts the proportion of the braking effects to the weight of the car and the gradients of the track, so that the maximum pressure possible, without causing skidding of the wheels, may be divided between the shoes of the electro-magnet and the rim brakes. In the Exhibition, where a car of the weight of 12 tons, empty, was used, the thrust on the track was equal to that on the wheels, but with an 8-ton car 60 per cent. of the thrust is applied to the rail and 40 per cent. to the rim shoes. How smoothly and accurately the whole system works was noticed by all visitors to the Exhibition and most of them no doubt formulated the wish to see it in practical operation in the metropolis and the suburbs.

THE HELICOID LOCKNUT PATENTS COMPANY.

Somewhat to the left of the Westinghouse generating plant, in the Tramways and Light Railways Exhibition, the Helicoid Locknut Patents (Parent) Company, Limited, had a small exhibit, showing the manufacture of its products from the rolled bar of steel to the finished nuts. These nuts, which now have been in the market for three or four years and are in great demand, embody the principle of a spring acting circumferentially on the bolt. To obtain this the nuts are tapped slightly smaller in diameter than the bolts on which they are intended to be used, but with the



MESSRS. DICK, KERR AND CO.'S EXHIBIT : FOUR WHEEL DOUBLE DECK CAR.

same pitch or thread. This results in a slight expanding of the coil when the nuts are placed in position, which brings the spring of the coil into action. On examining the nut it is found that the coil is so formed as to lend itself to the action of the spanner, thus enabling the nut to be placed in position or removed without injury to itself or the bolt.

ELECTRO MAGNETIC TRACTION CO.

Parallel with the Westinghouse car-track, but behind it and close to the wall, the Electro Magnetic Traction Co., of 39, Hamilton House, Bishopsgate Street Within, London E.C. displayed a working model of a surface contact system with closed conduit designed by Mr. Howard Lane, M.E., of Birmingham. Among the claims made by the inventor is a device for preventing the corrosion of the contiguous surfaces resulting from the frequent opening and closing of a contact through which a current of electricity passes. His proposed remedy consists in filling the conduits with coal gas or other gas free from oxygen.

CHLORIDE ELECTRICAL STORAGE SYNDICATE, LTD.

Between the latter exhibit and and that of the Westinghouse Company in stall 17 the Chloride Electrical Storage Syndicate, Limited, had an assortment of storage batteries composed of chloride cells, named after the chloride of lead, which is the chief component of the negative plate. These batteries are used for pressure regulation on various electric tramways and railways in many towns: among them, to mention Great Britain only, Leeds, Liverpool and Halifax. Their special virtues are mechanical strength and their ability to withstand high rates of charging and discharging.

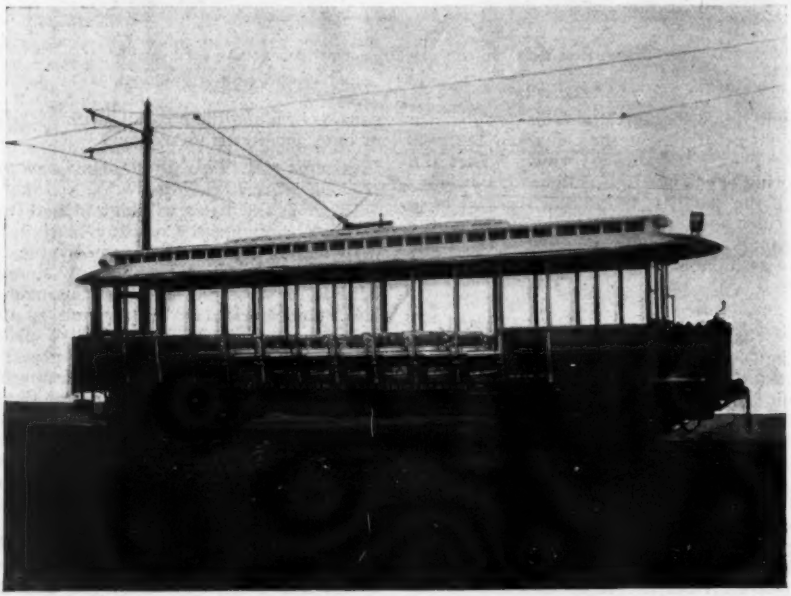
MESSRS C. W. BURTON, GRIFFITHS AND CO.

In stall 20, in the centre of the entrance to the hall, Messrs. C. W. Burton, Griffiths and Co., of 1-3, Ludgate Square, Ludgate Hill, London, E.C., showed a fine collection

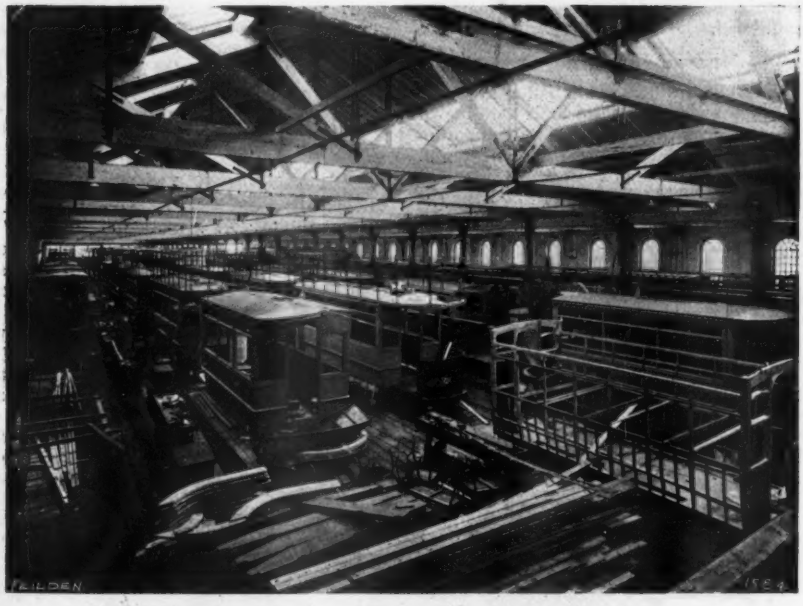
of machine tools, some of them in operation. Among the latter may be mentioned a new portable track drill, described as No. 18 "Burnham," and a portable rail sawing machine, particularly convenient for repair work, owing to its lightness, as it weighs only 285 lbs. There was to be seen also a great variety of ingenious tools, together with corundum emery wheels, carborundum goods and other accessories.

DICK, KERR AND CO., LTD., ENGLISH ELECTRIC MANUFACTURING CO., LTD., ELECTRIC RAILWAY AND TRAMWAY CARRIAGE WORKS, LTD.

Stalls 25, 26 and 27 contained the very attractive combined exhibit of Messrs. Dick, Kerr and Co., Ltd., of the English Electric Manufacturing Co., Ltd., and of the Electric Railway and Tramway Carriage Works, Ltd. The magnificent works of the English Electric Manufacturing Co., Ltd., in Preston, which were formally opened on June 14th last year, represent one of the most notable signs of British Industrial Progress and with Mr. S. H. Short, formerly the managing director and technical head of the Walker organisation in the United States and now technical director of the British Company, it will aid not a little in regaining for Great Britain whatever she may have lost in industrial supremacy. The contractors who carried the entire undertaking to completion were, as is well known, Messrs. Dick, Kerr & Co., Ltd., who were, as above stated, represented in the joint exhibit. The latter consisted of specimens of rails with "Dicker Patent Continuous Joint," special track work, poles and brackets and various types of cars. Among them was to be seen a bogie vestibuled top-seat car for heavy city service, manufactured by the Electric Railway and Tramway Carriage Works at Preston, with electrical equipment by the English Electric Manufacturing Co., Ltd.; a bogie cross-bench car for high speed summer suburban service, also the joint



MESSRS. DICK, KERR AND CO.'S EXHIBIT: BOGIE CROSS BENCH CAR FOR HIGH SPEED SUMMER SERVICE.



THE CARRIAGE ERECTING SHOP OF THE ENGLISH ELECTRIC MANUFACTURING CO., LTD., PRESTON.

work of these two companies, as well as a four-wheel top-seat car and a four-wheel single deck car of the same origin. Besides these may be mentioned a truck with motors and air brakes, motors, controllers, etc., designed by Mr. Short and manufactured by the English Electric Manufacturing Co., and a motor-driven compressor of the standard air brake type.

J. G. BRILL COMPANY, OF PHILADELPHIA, PENN., U.S.A.

A convertible Car for summer and winter use figured in enclosure No. 28, exhibited by an American firm, the J. G. Brill Company, of Philadelphia, Penn., U.S.A. The ease with which this car could be changed from a closed into an open car by making the windows disappear in the roof attracted the amused attention of many visitors. The arrangement is said to be popular in many places where it has been introduced and has met with great success in Buenos Ayres.

BRUSH ELECTRICAL ENGINEERING CO., LTD.

The Brush Electrical Engineering Co., Ltd., had its exhibit at No. 30. The excellent products of this company are so well established all over the world that little need be said regarding their quality. A car to seat 44 passengers, divided into two compartments if desired, the entrance being in the middle, and described as a bogie Vestibule Car, from the fact of its running on bogie maximum traction trucks, occupied a prominent position. A tramway motor, described as type A., and rated at 25 h.p. was seen to be a four-pole iron-clad dynamo with ventilated armature and laminated pole pieces. The field coils were wound on brass spools allowing of easy renewal. Besides these, there were to be seen a tramway controller, type H. 2, with emergency electrical brake and interlocking handles, and a "regenerative" tramway controller, type H. G. 2, by means of which the weight of a car descending a gradient can be utilised to generate a current and

return the energy to the line, may be mentioned.

MELDRUM BROTHERS, LTD.

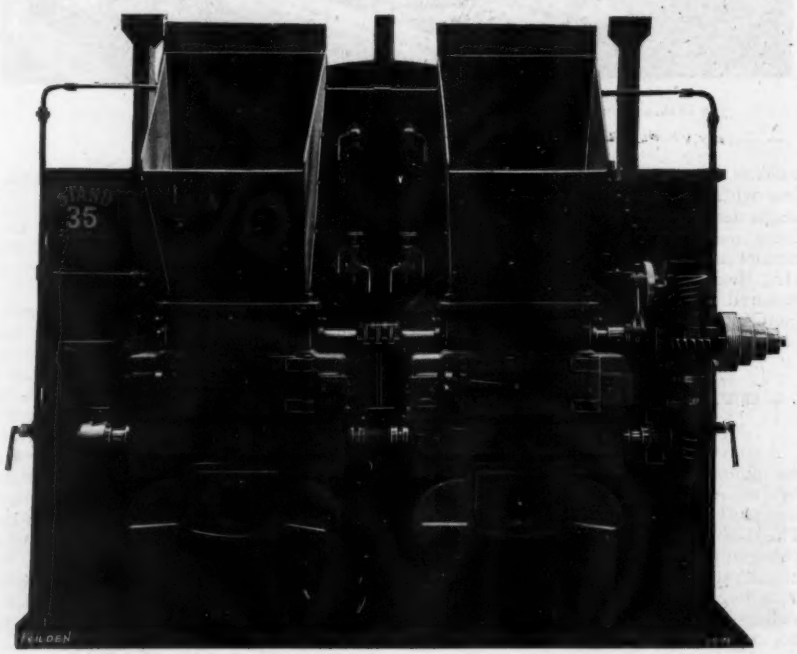
Meldrum Brothers, Ltd., had a display at No. 35, showing models of their well-known "Koker" mechanical stoker in combination with the forced draught arrangement, and the Meldrum "Simplex" Refuse Destructor which is working in connection with the Darwen Electric Supply Station, where the refuse of the town supplies all the power for the works and will furnish that for working the electric tramways when completed.

ELLIOTT BROTHERS.

In the stall next to that of Meldrum Brothers, No. 36, was to be seen the exhibit of Elliott Brothers, Century Works, Lewisham, S.E.; London Office: 101, St. Martin's Lane, W.C., consisting of a great variety of electrical testing apparatus; among which the very elegant and compact Board of Trade Panel, fitted with all the instruments necessary for carrying out the tests required by the Board of Trade Electrical Department in connection with tramway undertakings was much admired.

ROBERT W. BLACKWELL AND COMPANY.

Messrs. Robert W. Blackwell & Co., Ltd., 59, City Road, London, E.C., occupied stall 37. It was Mr. Robert W. Blackwell who constructed and operated (1881-1884) the commercial electric tramways in this country on both the overhead trolley and the sub-surface constant system; and the first commiercially successful trolley line at Bristol was erected by Robert W. Blackwell & Co., Ltd., and has been in constant and uninterrupted use since October 1895. Amongst the exhibits of this well-known firm at the Tramways and Light Railways Exhibition were to be seen four



MESSRS. MELDRUM BROS. EXHIBIT: IMPROVED PATENT MECHANICAL STOKER.

types of poles for overhead trolley systems, two of these are supplied to the Liverpool Corporation, the third is furnished to the Norwich Electric Tramways Company, and the fourth is the "standard" type of the firm supplied to numerous lines. Historically interesting was the display of trolleys showing the trolleys first used in this country on the original Bristol line, namely the "Dawson" patent swivelling trolleys, manufactured by Messrs. Blackwell & Co. The "Ætna" insulators made by this firm were shown in various styles and sizes, among them such with bolts ¾ inch in diameter, known as "Liverpool Standard" and specially made to the specification of the late Dr. John Hopkinson. Rail bonds of the "Crown" and "Chicago" type were represented, being improvements of the first bonds used on electric railways and belonging to the copper type, while in the

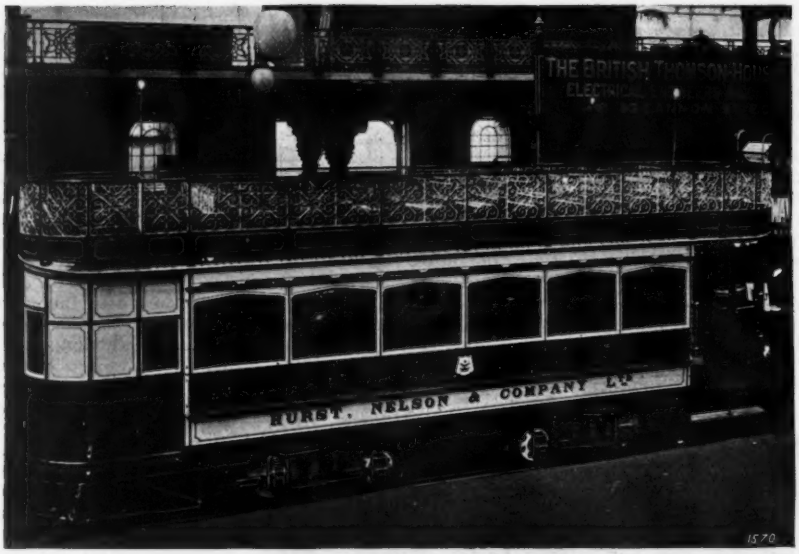
HAROLD P. BROWN

neighbouring stall, No. 38, Mr. Harold P. Brown, also of 59, City Road, E.C., his New York address being 120, Liberty Street, displayed specimens of "Plastic Rail Bonds," invented by himself and Mr. Edison. These bonds are described as an electrical connector for assuring the "return circuit" of electric tramways by means of the rails. They utilise the fish-plates, which mechanically connect the ends of the metals and dispense with the more elaborate and expensive copper connections formerly used, while there is no longer any necessity of drilling the rails. Messrs. Blackwell & Co.'s exhibits further contained drawings, showing in detail the plans and equipment, including Allis engines, of some of the power-houses equipped by the firm; points and crossings for special track construction, with specially hard manganese steel centres; steam fittings, electric fittings, car fittings, etc. Among the larger objects were a completely equipped single truck top-seat electric car, capable of seating 53 passengers, and four trucks of different types.

INTERIOR OF CAR SHEWN BY THE BRITISH THOMSON-HOUSTON CO., LTD.

BRITISH THOMSON-HOUSTON CO.

The British Thomson-Houston Company, Limited, had, of course, one of the most important displays in the Exhibition, which deserves a somewhat more explicit account. There were two fully equipped typical motor-cars built by Messrs. Hurst, Nelson and Company, Limited, of Motherwell, one of which was constructed for use in the London United Tramways, built to the designs of Mr. J. Clifton Robinson, C.E., fitted up in the most luxurious style and pro-

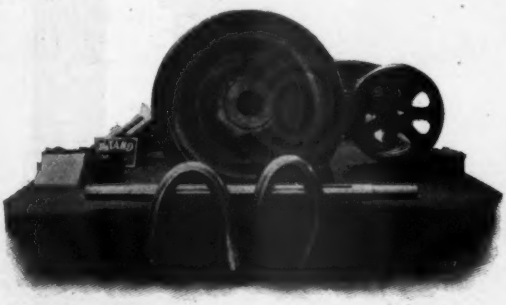


A CAR SHEWN BY THE BRITISH THOMSON-HOUSTON CO., LTD.

vided with incandescent lamps, inserted in the ceiling, covered with cut glass globes and set directly over the seats, so as to give ample illumination for reading. The body of the car was mounted on what is known as "Peckham" trucks, equipped with the special "B. and L." motor rheostatic brake equipment.

In order to show the electric equipment in detail, a standard Hurst Nelson truck with extension springs was exhibited, on the axles of which were mounted two G.E. 58 motors with enclosed gear cases. These motors are suitable for both "standard" and "narrow" gauges, and are intended for comparatively heavy service. According to whether the armature is wound with 7 or 6 turn winding they will supply 37 b.h.p. and 27 b.h.p. respectively and they are connected to a Series Parallel Magnetic Blow-out Controller of the Rheostatic Brake type, so as to show the efficiency of the rheostatic method of electric braking. The series parallel control is stated to save 50 per cent. of the current that otherwise would be required on those parts of the line where sufficient speed is obtained by working each motor at half the full line voltage, which is done by connecting the two motors in series. The least saving is effected under conditions where the cars run at high speeds with infrequent stops, or where the road bed is all up grade and down grade with cars running at full speed up grade and with no current down grade. As a current at 500 volts must be broken thousands of times each day between the controller contacts, the apparatus is constantly subjected to mechanical shocks, and the only practical and economical method of breaking the arc, formed at the finger contacts on interrupting the circuit, is that which uses the magnetic blow-out device, which extinguishes the arc as soon as it is formed. This device, in its application to controllers, is covered by patents owned exclusively by the British Thomson-Houston Company which claims that, contrary to what is often believed, the burning effect of the arc upon contacts protected by a magnetic blow-out is so slight that controllers which have operated for thousands of miles show no serious wear of contacts. The controllers serve for controlling the direction of rotation of the motors as well as the amount of current they take. When the motors are connected in series they consume less current than when

PYRAMID OF GRIFFIN WHEELS WEIGHING OVER A TON DEPENDING FROM CAST-IRON TEST-BAR ONE INCH IN SECTION CAST FROM METAL OF WHICH THE WHEELS ARE MADE.



GRIFFIN CHILLED IRON DOUBLE PLATE WHEEL 45-IN. DIAMETER, CAST IN ONE PIECE.

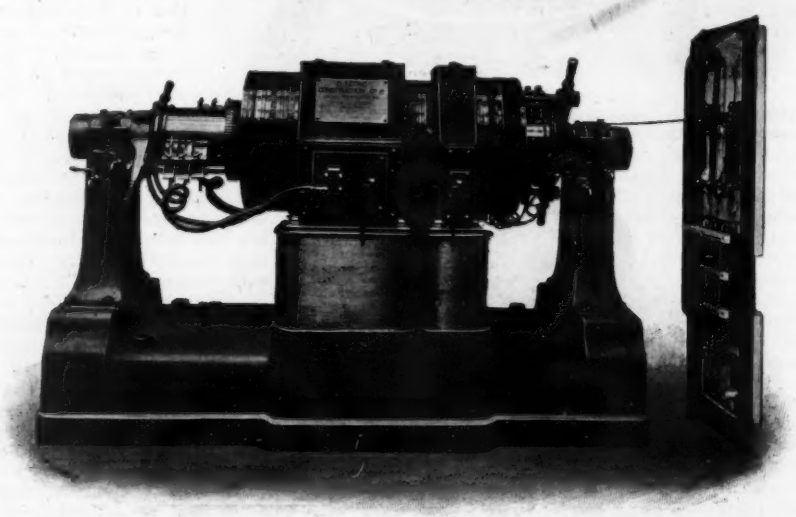
BRITISH GRIFFIN CHILLED IRON AND STEEL CO.'S EXHIBITS.

connected in parallel, as is the case when the cars run at high speed. The operation of the Rheostatic Brake is secured by connecting the motors in such a way as to convert them, for the time being, into generators, and thus transforming the kinetic energy stored up in the car in consequence of its rapid motion, into electric energy, which is dissipated in suitable resistances in the motor circuit. The transformation of energy is so rapid that an exceedingly effective reduction of speed is obtained, the amount of reduction being entirely under the control of the motor man. In the type of brake exhibited no brake shoes were to be seen, they not being required for effective retardation. Among the other exhibits of the British Thomson-Houston Company was to be seen also a great variety of accessory apparatus, such as resistance boxes, circuit breakers, lightning arresters and other objects required for the equipment of a car. One of the Company's Standard forms of lightning arresters was shown in operation so as to illustrate the efficiency of the magnetic blow-out principle. Overhead material was represented by numerous samples and an idea of the conduit system was given by a length of conduit complete with conductors, insulators, etc., having on top a truck with contact "plough" so arranged that the methods of raising the latter, and the general principles of the conduit system could be easily explained to visitors. To do the same with reference to a surface contact system, a few surface contact studs were shown with switches and collecting skates, connected with banks of lamps so placed as to light up in succession as the collecting skate moved over

the contact studs. In this way the progression of the car could be marked so as to show that the studs are "alive" only underneath the car and become "dead" immediately the car has passed. The whole exhibit gave a very fair idea of the great variety and ingenuity of the apparatus manufactured and the systems represented by the British Thomson-Houston Company.

BRITISH GRIFFIN CHILLED IRON AND STEEL COMPANY, LIMITED.

Another very interesting exhibit was that displayed in a neighbouring stall, No. 41, by the British Griffin Chilled Iron and Steel Company, Limited, organised to manufacture in England the Griffin chilled iron car wheels, many of which have already been supplied to English Electric Tramways by the New York Car Wheel Works in America. We regret that the natural limits of this article do not permit us more than to touch merely upon this and many other highly interesting displays, but we hope to find an opportuity to speak of them more fully on some later occasion. Works of this company are being constructed in Barrow-in-Furness and meanwhile England and her colonies will be supplied from the Buffalo (New York) branch of the New York Car Wheel Works. On the Continent the Griffin Wheels are being manufactured by many of the most famous concerns. These wheels owe their superiority in part to the special properties of the iron used in their manufacture, and are cast with the special object of obtaining, in a single casting, a tough, strong, grey wheel-centre, showing the carbon to be in a graphitic state, which at about $\frac{3}{8}$ inch to $\frac{1}{2}$ inch from the tread, changes very gradually into a hard white iron of combined carbon which is required for the wearing surface of the tread and flange; and this change from the grey to the white iron must be so gradual that there will be no possibility of the wheel showing weakness in that portion. The only ore found suitable so far for the Griffin chilled castings is bog ore, existing in large tracts at Radnor, Quebec, not far from the town of Three Rivers, on the St. Lawrence. This ore is raked up from under water in marshes, and made into pig iron in charcoal furnaces, by the Canadian Iron Furnace Company. So satisfactory has been found the use of this ore in mixture with certain other brands of pig iron, that it was possible to make castings direct from the cupola, which, in the form of plates, can be punched in the ordinary way, when cold, without cracking or showing any signs of fracture. Bars



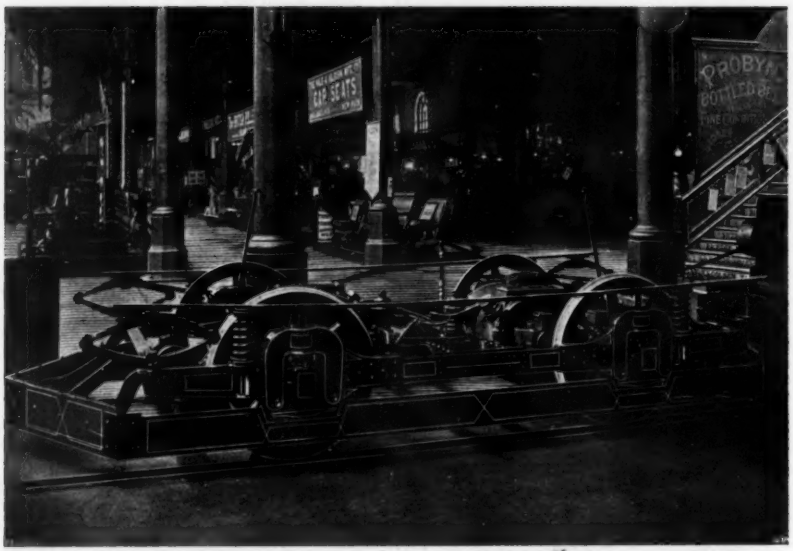
CONTINUOUS CURRENT TRANSFORMER SHEWN BY THE ELECTRIC CONSTRUCTION CO. LTD.

MESSRS. ASKHAM BROS. AND WILSON'S EXHIBIT OF TRAMWAY TRACK MATERIAL.

made from this special mixture, have been bent double, and even knotted, when cold, without showing any flaw whatever on the surface. The C.I.F charcoal pig iron is now supplied from Canada to all European works manufacturing Griffin chilled castings. A feature of great importance in the manufacture is the Griffin system of comparative tests, which secures an astonishing uniformity of strength and toughness in the wheel body and resistance to wear on the tread of car wheels. Under this system of "Comparative Tests" every Griffin car wheel is marked and its character indicated in such a way as to make it possible to identify it by referring to the records of the foundry. One of our illustrations shows a pyramid of nine Griffin wheels, weighing over a ton and hanging from the centre of a small cast-iron "test bar," twelve inches long and one inch in section, which was cast from the identical metal of which the wheels are made. The other shows a Griffin Chilled Iron Double Plate Wheel, 45 inch diameter, cast in one piece and weighing 1,250 lbs., as supplied under Baldwin Locomotives to the Egyptian State Railways, and, under Brill Electric Locomotives, to the Western Railway of France. The "cold-finished" axles come from the mill, finished smooth and true for their entire length, and have a greater elasticity than hot-forged axles, and the samples shown in our illustration were bent double, while cold, without a fracture on the surface. The London offices of the British Griffin Company are at 18, St. Swithin's Lane, E.C., and the directors of the Company are W. M. F. Schneider, Esq., Director of the Barrow Hæmatite Steel Company, Limited, chairman; P. H. Griffin, Esq., President of the New York Car Wheel Works; Colonel Sir Charles Euan-Smith, K.C.B., C.S.I., chairman of the Cape Electric Tramways; Sir Douglas Fox, Edward Kraftmeir, Esq. and S. Singer, Esq., of Paris; the latter being a member of the boards of directors of all Griffin Companies.

ELECTRIC CONSTRUCTION COMPANY, LTD.

To the right from the British Griffin Company, in stall No. 43, the Electric Construction Company, Ltd., of Dashwood House, 9, New Broad Street, London, E.C.,



MESSRS. FRANK SUTER AND CO.'S EXHIBIT: TRUCK SUCH AS IS USUALLY BUILT FOR A 40-IN. GAUGE.

with works at Bushbury, Wolverhampton, exhibited its products; among them a 70 kilowatt variable ratio transformer of the type now largely employed in the distribution of current on the Oxford system, and similar to the machines used on the City and South London Railway as reducers. There was also to be seen an alternating current transformer of the company's standard pattern, in which the iron circuit is composed of circular discs, thus enclosing the largest area with the smallest quantity of iron, and reducing the losses to a minimum. The radiating surface is also considerably increased in these transformers by using discs of different sizes, and in order to reduce magnetic leakage and to ensure a small drop in the case of inductive loads, the winding is split into a number of sections. The tram-car motor of 30 h.p. shown in the exhibit, was a fine specimen of what British manufacturers can accomplish, if they wish to, as regards compactness, strength and finish. Let us mention also one of the well-known "Bushbury enclosed" motors, specially adapted for rough work and designed to run without attention under sudden variations of load; an E.C.C. Standard type generator, so well known for its high finish and liberal proportions; a sample of a trolley for side suspension; some types of high class switch-work and finally a fine series of photographs, giving an idea of the wide compass of the company's manufactures, and it will be seen that the Electric Construction Company contributed a considerable share of objects of interests to the Exhibition.

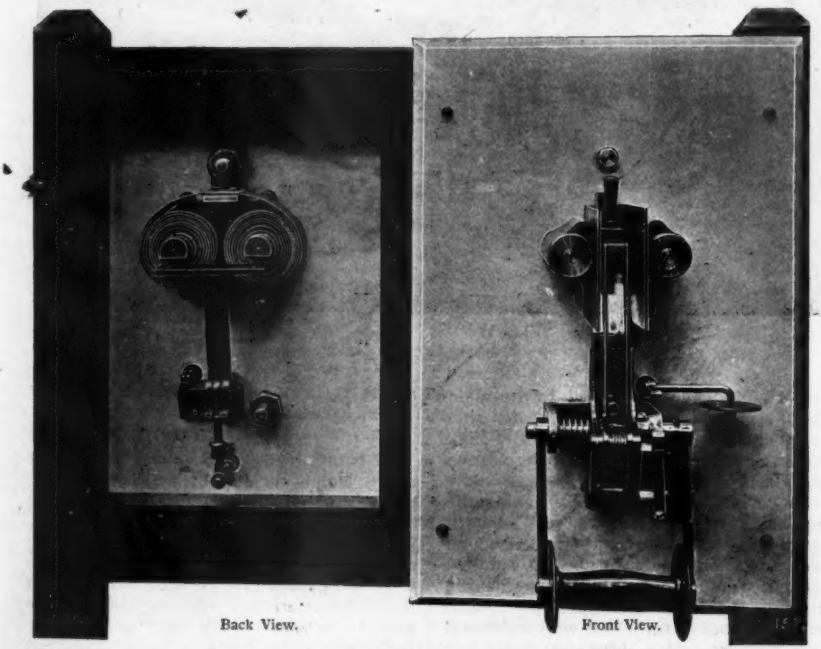
ELECTRICAL POWER STORAGE COMPANY.

The Electrical Power Storage Company, of 4, Great Winchester Street, London, E.C., which, as our readers will know, devotes its entire energy to the manufacture of electric accumulators, exhibited, in stall 48, a considerable number of various types of cells. The company occupies the front rank in its speciality of manufacture and is selling, as we are informed, plates at the rate of nearly one million per annum. Among the various types the most noteworthy are the "Q" type for portable work, the "L" type for low discharges over long periods, the "K" which can be discharged in three hours, and the "KWS"

and "KLP" types which are capable of being discharged in two hours and one hour respectively, without causing the slightest injury to the plate. The latter is extensively used for electric power stations and gives great satisfaction. Amongst the customers for this type are the Liverpool Corporation, which has received a battery of 1,212 cells, the Liverpool Overhead Railway, the Birkenhead Corporation, that of Bradford, and many others. The company also exhibited a battery of 40 cells of their well-known Faure-King type, such as is used for running the electric cabs of Paris. Each of the cells consists of 13 plates and we are assured that the battery will run a cab without renewing its charge for 50 miles. Another battery shown consisted of 250 cells, and was specially built for the use of certain tramway companies which can obtain a concession for trolley wires in some streets, but not in others, and must in the latter case rely upon accumulators for motive power. Notwithstanding the great number of cells, this battery is comparatively light for its efficiency and is constructed in the most compact manner possible.

ASKHAM BROS. AND WILSON, LTD., OF THE YORKSHIRE STEEL AND ENGINEERING WORKS, SHEFFIELD.

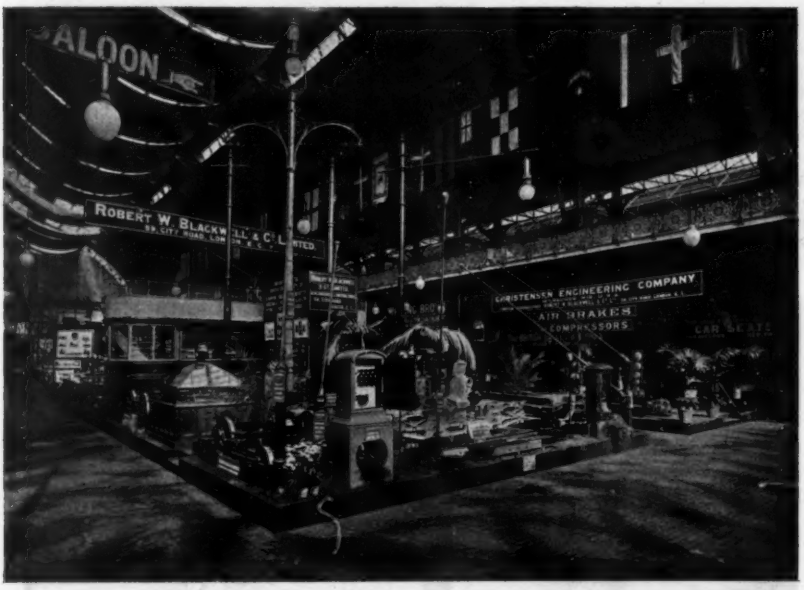
A particularly fine exhibit was that of Messrs. Askham Bros. & Wilson, Ltd., of the Yorkshire Steel and Engineering Works, Sheffield, who made a very striking display of tramway track material, comprising their special patent, automatic fixed and moveable "points" of best crucible cast steel with cast steel crossings to correspond, of which, as we understand, many thousands are in use throughout Great Britain and Ireland and give complete satisfaction. Among the exhibits were large quantities of "points" made for Nottingham, Halifax, Birkenhead, Liverpool, Bolton, etc., ready to be sent to their destination directly from the Agricultural Hall immediately after the closing of the exhibition. Conspicuous were the patent "automatic fixed point" and also the moveable point for tramway junctions.



Back View. Front View.

"HELIOS," AUTOMATIC MAXIMUM CUT-OUT—SWITCH-BOARD PATTERN BY FRANK SUTER AND CO., LTD., LONDON, W.

The peculiarity of the latter point is that the spring works underneath the tongue, so as to hold it rigidly against either side of the point which prevents the hind wheels of the cars from taking the wrong track. There were to be seen also specimens of "Dawson's Patent Drain Rail," in best crucible cast steel, such as have been supplied for Leeds, Blackburn, Sheffield, Plymouth, Huddersfield, Bristol and other places. This drain rail takes the place of ordinary rails over certain distances and forms a drain which, when connected to the main sewer, clears the roads of any water that may accumulate, even during a heavy rain. The drain rail, moreover, can easily be cleaned out when choked, which, however, very rarely occurs. Of interest also among the company's exhibits were "Marshall's Patent Joint Plates" for electric traction, of which three types were shown, one with stamped steel clips for repairing and strengthening existing lines where it is impossible to drill the rails, another furnished with bolts and taper washers, and a third with bolts and long taper steel trips, the last two types being designed for new work. In conclusion may be mentioned a selection of platelayers' tools and other tools required in tramway construction work, as well as nuts, rolled steel tires, special trackwork, specimens of the tramway "star" crossing to be used at rectangular track crossings, and finally a collection of photographs illustrating the company's works in various places.



THE STAND OF MESSRS. ROBT. W. BLACKWELL AND CO, LTD.

HELIOS ELECTRICAL CONSTRUCTION COMPANY LTD., REPRESENTED BY F. SUTER AND CO., LTD., OF 66, BERNERS STREET, LONDON, W.

At Stand No. 50, was shown the exhibit of the Helios Electrical Construction Company, Ltd., represented by Messrs. Frank Suter & Co., Ltd., of 66, Berners Street, London, W. The products of this flourishing concern have been so often described in the technical papers that we need not dwell on their characteristics. Among the exhibits were to be seen a truck such as is usually built for a 40 in. gauge, a motor protected

by a frame cast in two pieces, a "resistance" permitting single coils to be removed without disturbing the whole, and numerous other electrical devices. Special mention perhaps should be made of the "electric disc brake" of a comparatively recent date, in which use is made of the Foucault, or eddy, currents. The cars furnished with this brake have a motor on one axle and the brake on the other, the latter being used to stop the car; the ordinary brake-shoes are discarded and thus the wear and tear on the wheels greatly reduced. The electric brake consists of the electro-magnets which, by being fixed to the truck, are prevented from rotating, and of the armature, which is so keyed to the axle that during its rotation it also moves slightly along the axle in a horizontal direction, which latter movement is effected by means of fly weights attached to the levers, which open and close according to the speed of the axle, a sliding piece on the ring engaging with the inclined grooves of the ring. The brake magnets receive their current from the motor which, for the time being, acts as a generator. In this way the speed of both axles is retarded, the one by the motor acting as a generator, and the other by Foucault currents engendered in the armature of the braking apparatus. The exciting current in the brake magnets, although strong when the brake is first applied, gradually weakens as the speed decreases; at the same time, however, the fly weights close in towards the axle, and thus cause the armature to approach the pole-pieces, so that, while the air space, and consequently the magnetic resistance are decreasing, the effect of the brake, compared with that first obtained, remains nearly the same. As the speed is checked the exciting current of the magnets and the produced Foucault currents are, by reason of the slow movement, very small, and the armature is pressed against the brake magnets, thus forming a mechanical brake which reinforces the Foucault currents and stops the car.

CHRISTENSEN ENGINEERING CO., OF MILWAUKEE, WIS., U.S.A.

A good deal of attention was attracted by the very interesting exhibits of the Christensen Engineering Company, of Milwaukee, Wis., U.S.A., having their London office at 59, City Road, E.C. There was to be seen, for instance, an air-brake apparatus for a train of five cars, controlled and operated from one motor-car.

This system is automatic and so arranged that should the train break in two the brakes will be immediately set and can only be released by the motor man or engine driver. The brakes can also immediately be set by pulling the cord passing through the cars. The triple valve which operates the brake cylinders has but five moving parts, far less, therefore, than in any other triple valve in the market. The motor man does not attend either to the electric compressor controller or the automatic controller, or to the reservoirs; his full attention, therefore, can be given to the running of the train and the controlling of it by the engineer's valve and the air gauge.

Another exhibit consisted of a plain air brake for a train of two cars, worked in a similar manner. The action is somewhat slower, though it is also automatic in its control of the cars and in its complete operation. There are, as we have been informed, over 3,000 of these motor compressors in operation in the larger cities of the United States, and the system has been adopted by all the elevated railroads in the city of Chicago, where, in places, the trains run from 50 to 100 ft. above the level of the street.

All the products are made in their entirety in the works of the Company, and a proportion of the work is sub-let to others, so that the Company guarantees all its work. There is a prospect, we are told, in case the enterprise is met with encouragement, to establish an entirely British Works of the same kind.

WITTING BROTHERS, LTD. OFFICE AT 49, CANNON STREET, LONDON, E.C.

One of the Continental companies, Witting Brothers, Ltd. (Electricité et Hydraulique) with works at Charleroi, Belgium, and Jeumont, France, having an office at 49, Cannon Street, London, E.C., was represented, at stall 52, by quite a variety of exhibits. We notice a standard truck for light railways and tramways, equipped with two standard motors of 30 b.h.p., 500 volts, and 550 r. per minute, which is in use in Paris, Galatz, Valencia and other Continental towns; a selection of car-fittings; several specimens of slow-speed motors; a 50 k. w. motor generator, driving a continuous current dynamo generating current at 500 volts; three-phase transformers; an electric percussion rock-

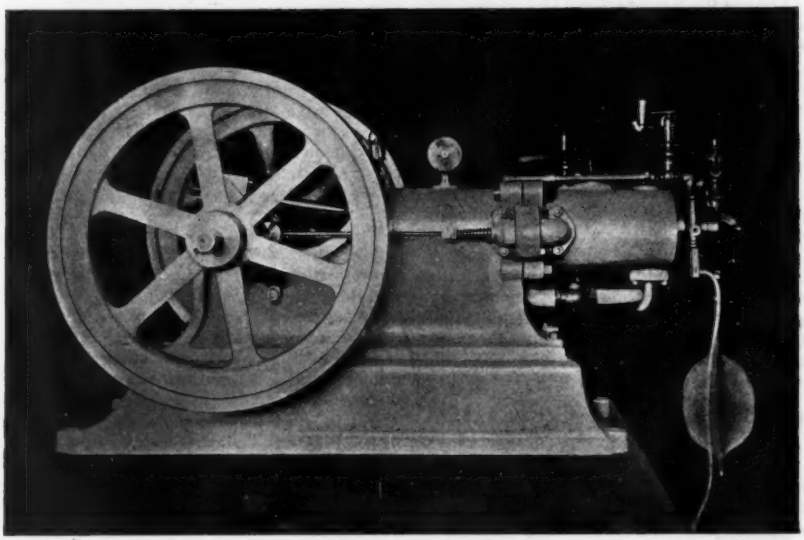
drill ; and a collection of arc lamps, switches and fuses, manufactured by the Electricité et Hydraulique Company.

ROLLER BEARINGS COMPANY, LTD., OF 1, DELAHAY STREET, LONDON, S.W.

The Roller Bearings Company, Limited, of 1, Delahay Street, Westminster, London, S.W., had a display of samples, comprising railway and tramway axle boxes, as adapted to the Peckham and Brill trucks, together with shafting-bearings and trolley-bearings, suitable for light waggons for road or rail traffic. The bearings consist of an outer case of either steel or cast-iron, having a steel liner. The rolls, manufactured of polished compressed steel, are controlled by means of a gun-metal machined cage, made either solidly or in halves with a dove-tail joint, the rollers bearing upon the end only of the spacing-bars of the cage. For heavy loads a hardened steel sleeve is provided, which is pressed or shrunk on to the journals. End thrust is provided for by means of a metal pad, let into the cover, on which is cast a siphon lubricating box, by which a constant supply of oil is secured. These roller-bearings are well known in England and on the Continent, having been in use on many of the principal British and French railways, and upon various of our tramway systems.

FREDERIC NELL, 77, QUEEN VICTORIA STREET, LONDON, E.C.

Mr. Frederic Nell, whose local address is 97, Queen Victoria Street, London, E.C., exhibited the working of a variety of American machinery, among them a "jet condenser," designed by Smith-Vaile, of Dayton, Ohio, U.S.A. This condenser is of the single-cylinder type, having the advantage of completing its stroke before the next can begin, and in it the percentage of clearance is reduced to a minimum, ensuring a vacuum up to 28 in. This type of condenser may be driven by steam power or by electric motor through gearing. Mr. Nell also showed an illustration of a separator and a grease extractor, in both of which centrifugal force is used to perform the work. Thus, the separator consists of a horizontal or vertical tube, with the receiver placed below. Inside is a cone on which are cast spiral fins, giving a rotary movement to the steam, and the entrained water is thrown by centrifugal force to the sides of the tube, from which it flows by



NEW TYPE OF GAS ENGINE BY THE BLAXTON ENGINEERING CO., LTD., DRIVING SOME OF THE EXHIBITS OF MESSRS. JOHN GIBBS AND SONS.

gravity into the receiver. In the grease-extractor the cylinder oil, which should not vaporise below 300° F., is eliminated by the same centrifugal method, so that it cannot enter the condenser, where it would reduce the efficiency of the cooling surfaces.

E. BENNIS & CO., OF BOLTON.

Messrs. Edward Bennis and Company, of Bolton, with London offices at 29, Victoria Street, Westminster, among other exhibits showed samples of "Geipel's Steam Trap," or automatic drain cock, of which this Company are the sole vendors. This ingenious device, in addition to the gold medal, received a special prize of 1,000 frcs. at the Brussels Exhibition in 1897, and is used by the British Admiralty for 300 lbs. pressure. Steam traps, as all engineers know, usually require a good deal of attention and are apt to cause considerable trouble. M. Geipel's invention therefore has added considerably to the economy and efficient working of engines and to lessening the labour of those in charge of them.

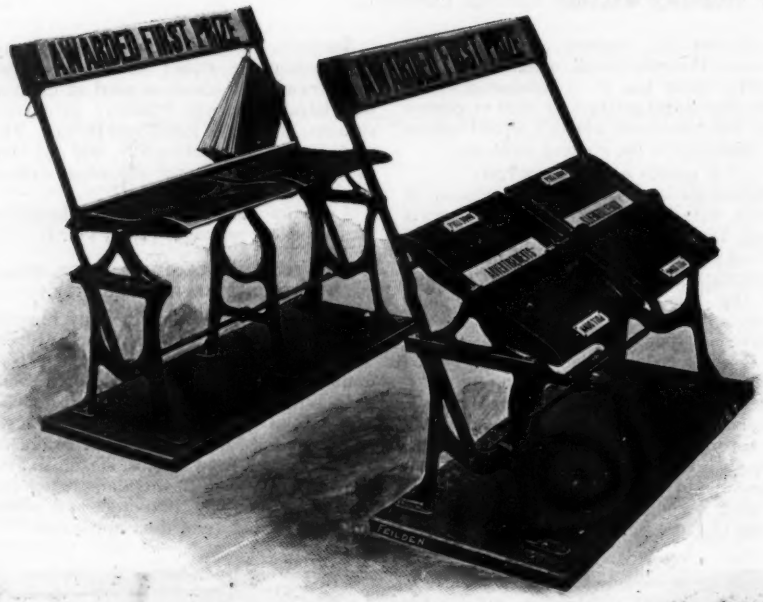
Another exhibit showed the Bennis patent machine stoker and self-cleaning compressed air furnace as used at many of the latest electrical tramway generating stations, notably at Leeds and Bolton. This machine raises steam rapidly, and any class of coal can be used with advantage without smoke.

A full illustrated description of the apparatus appeared on pages 120-1, Vol. I.

KLEIN ENGINEERING COMPANY, LTD., OF 94, MARKET STREET, MANCHESTER.

The Klein Engineering Company, Limited, of Cleveland Buildings, 94, Market Street, Manchester, has an exhibit comprising models of their well-known patent water coolers for cooling water required for condensing the exhaust steam from engines at power stations, and a small oil-separator for eliminating oil from exhaust steam, so as to prevent it reaching the condenser, together with a collection of drawings and photographs of a variety of their apparatus.

BLUE ASBESTOS REMOVABLE PIPE COVERINGS AT THE METROPOLITAN ELECTRIC LIGHT COMPANY'S STATION AT WILLESDEN. THE ILLUSTRATION IS FROM A PHOTO EXHIBITED AT THE CAPE ASBESTOS COMPANY'S STALL.



MR. PETER BURNS' EXHIBIT. PRIZE SEAT FOR TOPS OF TRAMCARS AND OMNIBUSES.

CAPE ASBESTOS CO., LTD., OF 8, MINORIES, LONDON, E.C.

The Cape Asbestos Company, Ltd., of 8, Minories, London, E.C., had a display comprising a vertical steam boiler covered with their patent blue asbestos removable mattresses, and also steam and hot-water pipes, flanges, bends, &c., covered by the same material, and a show case containing samples of blue crude asbestos in various forms, illustrating the mode of manufacture of their goods from the crude rock to the finished coverings. The asbestos used is a variety of the mineral found in Cape Colony, distinguished by a remarkably low weight and great strength of fibre. The coverings are made after the fashion of a quilt, but containing loose asbestos instead of eider-down, and enclosed in a fabric of the same article, stitched through with asbestos twine. Jackets of the material can in this way be made to fit any kind of contour, and, since the asbestos coverings never rot and are not affected by the heated surfaces which they envelop, they will last an indefinite time without being renewed. As they can easily be removed and replaced, they offer no obstacle to necessary repairs of the boilers or pipes which they cover and for which they serve as very efficient heat insulators.

ANTI-FRICTION ALLOYS, LTD., 52, VICTORIA STREET, LONDON, E.C.

Stall 76 contained a selection of products of the Antifriction Alloys Co., Ltd., of 52, Queen Victoria Street, London, E.C. Among these were to be seen specimens of Atlas anti-friction metal (W. E. Watson's brand), especially adapted for car bearings; Atlas Metal car bearing, specially designed to overcome certain difficulties experienced when a white anti-friction metal is used for car-bearings, and the efficiency of which is demonstrated by specimens which have run for a considerable period; cast-iron (Atlas-lined) car-bearings, cheaper and far more durable than brass, and many other varieties.

JOHN GIBBS & SONS, of 72-76, DUKE STREET, LIVERPOOL.

John Gibbs and Son, of 72, 74, and 76, Duke Street, Liverpool, with London offices at 15, Victoria Street, Westminster, had a display of ventilating fans of various sizes and worked by various methods, together with allied appliances. Their most interesting exhibit, however, was undoubtedly a

gas-engine designed and constructed by the

BLAXTON ENGINEERING CO., LIMITED,

of 69, Old Street, London, E.C. This engine is of a novel type and gives an impulse every stroke. The engine has two pistons connected to a common trunk; the back piston fits the usual working cylinder, whilst the front one fits bored guides. Between the latter and the trunk is left an annular place, forming a pump-chamber, communicating with an air vessel of suitable size. This renders it possible to regulate to the desired size the vacuum created in the pump-chamber during the out-stroke, toward the end of which the back piston uncovers a ring of port-holes which, by means of a non-return valve, communicate with the exhaust pipe, so that the cylinder pressure is immediately reduced to that of the atmosphere. The pistons, however, continue their stroke until an equilibrium valve is opened by a tappet under control of the governor, and communication is established between the working cylinder and the partial vacuum in the pump-chamber into which the products of combustion pass over from the working cylinder, a fresh charge being admitted into the latter by an inlet valve. On the return stroke, compression begins immediately the piston closes the port-holes previously mentioned, and as soon as, during the continuation of the return stroke, the back edge of the piston has passed these ports, uncovering them again, the contents of the bored guides escape through the non-return exhaust valve. Finally, the ignition of the charge is, in the ordinary way, effected by a hot tube.

The equilibrium valve is chiefly intended to supply the means for governing the engine, since, upon the speed increasing, the governor prevents this valve from being opened. As, consequently, no fresh charge is admitted into the working cylinder, the next out-stroke of the pistons is an idle one.

SIMPLEX STEEL CONDUIT COMPANY, LTD.

Another exhibit of interest was that of the Simplex Steel Conduit Company, Ltd., with works and head-office at Coventry Street, Birmingham, and a London office at 20, Bucklersbury, E.C. On a polished oak board, about 5·5 feet by 3 feet, mounted on a framework in a vertical position, were displayed specimens of the Company's various conduits and fittings. Occupying a central position was to be seen one of the Simplex five-way double-pole fuse distribution boards, from which specimen circuits were run to various lamps, in order to illustrate the Company's method of wiring. Near the top, a tube framework projected, carrying lampholder and pendant fittings, also connected with the distributing board, and in addition were displayed Simplex brackets, switches, ceiling roses, etc., and other accessories. The Simplex system has found extensive application throughout the country, which seems to endorse the statements of the manufacturers, who claim for their products economy in first cost, erection and maintenance, as well as lightness, simplicity, and, finally, durability, since all their tubes and fittings are protected by preservative enamel. The various parts, moreover, are easily accessible, and admit of ready inspection, as well as of convenient testing. The Simplex Steel Company is represented also in the British section of the Paris Exposition.

PETER BURNS, of 15, HAMPSTEAD ROAD, ELM PARK, LIVERPOOL.

In conclusion, it may be mentioned that in a prize competition arranged in connection with the Exhibition, Mr. Peter Burns, of 15, Hampstead Road, Elm Park, Liverpool, obtained the first prize for his type of a seat, to be used on top of tramcars and omnibuses, which will remain dry in all conditions of weather. The seat designed by him is an automatically reversing seat of the most simple construction. There is a conspicuous absence of levers, springs or weights, which are very apt to get out of order, and the reversal of the seat, if not in use, is secured by its being hung on a bar, just below the centre of gravity and being slightly overbalanced, so that the moment a sitter leaves it, it reverses by its own weight, exposing only its under surface to the weather. This under surface, meanwhile, being in view, offers a good opportunity for advertising, and will, no doubt, wherever the Burns seat is used on tramways or omnibuses, serve that purpose. By means of a bolt, fixed on the rod to which the seat is attached, the seat can be made absolutely rigid, if desired, and the inventor can be honestly congratulated for having solved the problem in so successful and simple a manner.

It has been impossible, in the limits of this comparatively short review, to mention

more than a certain number of the exhibits, of which there were 99 in the large hall, and it must be clearly understood that we do not wish to imply that those omitted were necessarily of inferior interest, as compared with those described, though we have endeavoured to give a fairly representative selection. There will be abundant opportunity for discussing the progress of electric traction in the columns of this magazine within the future, and we shall not fail to keep our readers informed regarding all improvements that deserve notice. Let us say merely that nearly all the exhibitors have succeeded in showing to their visitors that there is no reason, whatever to doubt that British manufacturers in this branch of industry, as well as in all others, will be quite able to occupy the first rank, when once they fully grasp the fact, as by this time, no doubt, they have done, that the applications of electricity are of so great and immediate an importance, as to deserve their fullest attention, and that it would be extremely unwise to leave so large a proportion of the field, as has hitherto been left, in the hands of foreign competitors.

WORKSHOP PRACTICE

The purport of this section of FEILDEN'S MAGAZINE is to give the skilled mechanic in our great industrial establishments an opportunity of bringing his practical ideas and experience into print. Inventive capacity and careful thought on the part of the workman is what we desire to encourage and foster. To this end we invite skilled mechanics, foremen, under-foremen, and heads of departments, to communicate practical suggestions, which, if accepted, will be suitably paid for. Wherever possible, drawings should accompany the contribution; rough sketches will suffice, as, when draughtsmanship is at fault, we will do all that is necessary to render them fit for reproduction. Nothing will be too poor for a careful inspection. It will be seen that those contributions which appear in this section show distinct merit, and are both interesting and instructive.

Notes on Screw-cutting, &c.—When turning or boring anything taper, or cutting screws of whatever shape or pitch, it is absolutely essential, in order to produce perfectly accurate work, that the cutting edge of the tool be exactly central, perpendicularly, with the material to be operated on. Most turners fix their tools above the centre more or less. By doing so, what they gain in cutting more freely on outside work is just reversed on inside work (Fig. 1). This, of course, also refers to plain turning, but in the case of taper work Fig. 2 will convey the idea of the effect of a high tool. *A* is the position of tool at the small end, *B* at the large end, *AB* line of travel of tool, *AC* line it should travel to produce perfect taper, which is impossible with high tool. Screw-cutting with high tool is perhaps worse, as no matter how accurately a tool is ground or fixed, the screw is bound to be out of square if not set central (Fig. 3). When a square thread is cut it is easily seen, and, the greater the pitch, the more pronounced it appears, and is generally the cause of a nut going easily on a screw one way and tight when reversed (Fig. 4). I have seen first-class men, on account of above, quite at a loss to understand the cause, and, thinking that the rake of tool was not correct, and pulling itself in advance of leading screw, or *vice-versa*, as the case may be. The same remarks apply to taper work; they could not understand why the work should fit at both ends, or else in the centre, as the case may be.

GEO. MUTLOW.

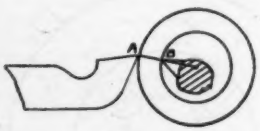


FIG. 1.

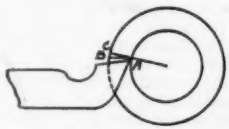


FIG. 2.

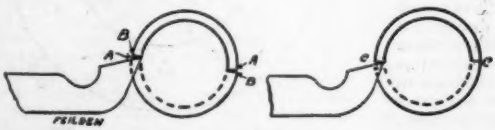
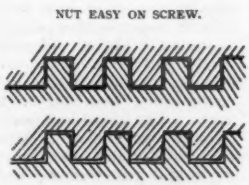


FIG. 3.

NOTES ON SCREW CUTTING.



NUT EASY ON SCREW.

NUT TIGHT ON SCREW.

FIG. 4.

Moulding a Vacuum Pan.—The moulding pit having been opened, the binding bars were first placed in position. This was done by putting down a bar, 9 in. square and 14 ft. long, across the centre of the pit, and then levelling it. Then two bars, 8 in. square and 13 ft. long, were laid parallel with the first and levelled from it. Across these three, in the order shewn in Fig. 1, were laid two others, each 8 in. square. Then the ground round and about the bars was rammed up to the top side of them, and a hole, 6 ft. deep and 1 ft. in diameter, left in the centre for the cross and the end of the bottom bars left clear about 1 ft. 6in. from the end. Then 1 in. of loam was laid on the top bars, and the plate with the cross being fixed in position was bedded down solid, and the spindle tried in, and made plumb. Stools were

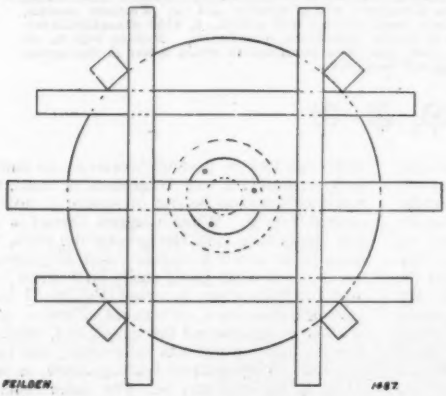


FIG. 1.—SHEWING BOTTOM PLATE AND BINDING BARS.

then put on the ends of the bottom bars between the plate and the bars, and made good with wedges. Thus the plate was solid in the centre and also round the edges. Next, the board was affixed to the spindle by means of four bolts through the shear iron at the top, and three bolts through the short shear iron at the bottom, as shewn in Fig. 4. Then the building began. First of all four courses of bricks on flat were built on the outside edge of the plate, and the centre filled with half bricks, brick chips, and ashes. The board had been kept high enough to allow this, and while many moulders would not consider this necessary, it was considered so in this case for two reasons, firstly, there were to be hundreds of tons of pans cast in this mould, and the idea in the extra courses of bricks was to create a reservoir for any gases that might be generated by successive casts; and, secondly, the pans were to vary in size, and if larger, we could strip off a course of bricks, and if smaller, we could build on a course of bricks. At the fifth course of bricks an opening was left at six different points in the building into which vent pipes could be inserted. The building was then carried right up to the top, a 9 in. wall built solid on the face of the mould, and an open building behind. The mould was then roughed up and left to stiffen. A fire was then kindled between the sides of the mould and the pit, and kept burning for two days, when it was drawn, and the ringers of the design shewn in Fig. 6, were put round the end of the bottom bars and made solid. Then the pit was rammed up to the openings in the building where the vent pipes were inserted. These were long enough to come 6 in. above the level of the floor. At the foot of them a quantity of ashes were placed to keep away sand, and make the connections between

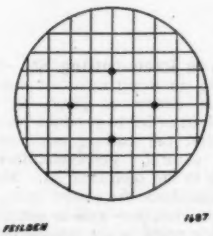


FIG. 2.—BOX GRATING AND LIFTERS MARKED THUS: ∘

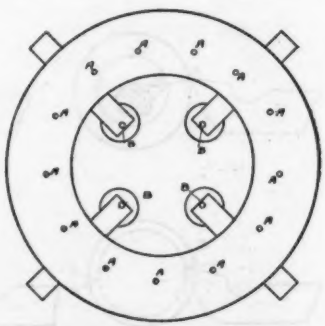


FIG. 3.—SHEWING DESIGN OF TOP CAKE WITH GATES AND BOLTHEADS. A, GATES, B, BOLTHEADS.

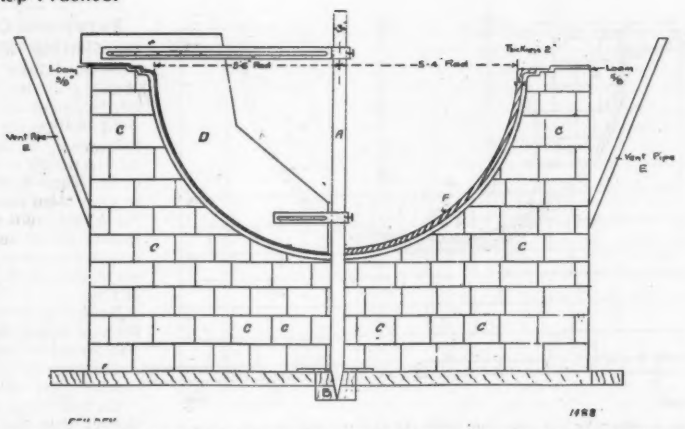


FIG. 4.—SHEWING MOULD [C], SPINDLE [A], CENTRE [B], VENTS [E], BOARD IN POSITION [D], AND THICKNESS ON [F].

the ashes in the mould and the vent pipe sure. Then the pit was rammed up to the top, and level with the floor, 6 in. of the building being above the level of the floor. A hoop iron was then tied round the top course of bricks, and the mould skinned up. The spindle was then taken out and a fire put in the inside of the mould, and allowed to remain in overnight. In the morning the mould was cleaned out and a spindle to fit the same cross was put in, and the board fixed to it. The reason for this was due to the fact that there were ten of the same size to be made, and by using two spindles, one for the mould sweep, and one for the thickness sweep, the trouble consequent on taking off, putting on, and setting of sweeps, was avoided, and a great deal of time saved. The thickness sweep having been set, the thickness was put on. This was done by laying 1 in. fire bricks on the face of the mould, claywatering them, and filling up the space between, and on the face, with sand previously put through a sieve. The sand was then sprinkled with water, and swept up with thin sieved loam. The spindle was then drawn out, and a fire put inside till the following day. The fire then taken out and the thickness blackwashed with parting blackwash, made up with common blacking and clean water. A little parting sand was then sprinkled on the blackwash and the core was begun. First of all the grating, as shewn in Fig. 2, was put in position as in Fig. 5, and rested on four 1 in. sconces. The squares in the grating were then filled with red brick built on end up to the top. A course of brick was then built round the edge of the grating, and on this course a building ring was bedded, being split at one place with small snugs cast on for a tier. A course of bricks was then built on the top of this, and a further course on the back of these, making a 13 in. wall, this being

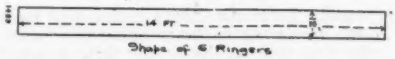


FIG. 6.

carried right up to the top of the core. Then 2 in. of loam was put on the top, and the top cake bedded down. The top cake (Fig. 3) had been made with 4 snugs to the insides with 2 in. holes in them, so arranged as to bring the eyes in the box grating directly under these, so that there would be no difficulty in getting the grating bolted up. So in laying on the top cake, care was taken that the holes in inside snugs came right above the grating lifters. When the top cake had been put down solid, the gates were put in and filled with parting sand. Marks were then made on the outside, and a fire lit in the inside, which was allowed to burn all night and the next day. During the time the fire was in the core, a cup was built to receive and act as a rest for the core (Fig. 5). This was put into the stove for a night and dried, and the following morning the hook bolts were fixed and screwed up till they were solid. The chains were then put on the four inside snugs, the crane set, and the top part lifted off, and set in the cup which was seated on the carriage. The cracks in the core were then ripped out and filled up, and the core put in the stove. While this was being done, the thickness was taken off the mould, and the mould fine carded and blackwashed. A fire was then put in it, and allowed to burn two nights. During the time the mould was drying we dressed and finished the core and gave it another night in the stove. Then the following morning the mould was cleaned out, the flange cores nailed on, and the core lifted and closed on. The joint was then loamed up and binding

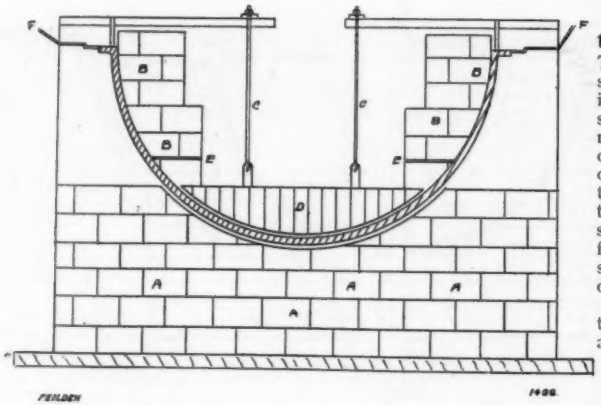


FIG. 5.—SHEWING CUP FOR CORE REST [A] AND SECTION OF CORE SEATED THEREIN [BB], WITH HOOK-BOLTS [CC] FOR LIFTING GRATING D, ALSO SPLIT BUILDING RING E AND FLOW GATES F.

began. Three bars were bound next the top cake answering to the undermost bars (that is, the ringers from the bottom three going over the top three). Two bars were then put in position answering to the two on the bottom; the bars were then made solid one from the other in the centre, and a plate was bedded on the top of the box grating from which a stay ran to the centre bar and was made fast, thus effectually preventing the pressure from sending up bricks through the grating. A row of bricks was then built to the inside edge of the plate to form part of the head, and a row of crib plates were put round about a foot from the side of the mould. Gate pins were then inserted and the head made up. The gates were 1½ in. long, and ½ in. broad; there were twelve gates, and four flow gates, cut on the joint, and carried up past the outside of the plate (see Fig. 5). The head being made up, an armful of shavings was thrown into the centre, and some put at each of the vent pipes round about. The mould was then very successfully cast. As soon as the head set it was broken up and the scrap taken away, the crib plates taken down, and the binders taken off. The top cake was next taken off and the building of the core ripped down to the split in the building ring. The tier was then taken off and the building ring eased up a little bit, thus allowing the casting to shrink without any danger of cracking. The following morning the casting was taken out, and the mould roughed up for the next one while still hot.

ANGUS C. MILLER.

An Improved Tool Holder for Slotting Machine.—The tool holder shewn by sketch will be found an improvement on the long, solid cast steel tools generally used, as the friction on the points of the latter on the return stroke is found to wear them more than on the actual cutting or down stroke, which necessitates frequent access to the grindstone, and consequent loss of time.

Referring to sketch, *A* is the tool holder bar of suitable strength. At the lower extremity is a hole into which the cutter *B* fits, the hole being somewhat deeper than the cutter as shewn. *C* is a cheese-head set screw, with head counter-sunk into bar *A*, and passing through hole in cutter *B*, thus acting as a pivot. *D* is a small screw and spring introduced in underside of *A* and pressing cutter *B* upwards. As will be seen the down or cutting stroke holds the tool up to the work by its own pressure, but on the return stroke the friction on the point of the tool slightly presses same downwards, compressing the small spring *D*. This spring should be so adjusted that it will just force back the tool to the position shewn on sketch, ready for the next cut.

Such an arrangement as shewn has been in use with a tool 1½ in. broad at point which would not cut paper on the return stroke.

Special Chuck for Square Centre.—Some time ago I was engaged in running a lathe that was chiefly used in turning shafting and cutting large screws, and, as I dare say some of your readers will have gone through the various difficulties attached to using the old form of square

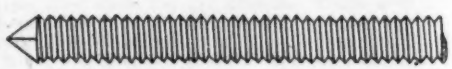


FIG. 1.

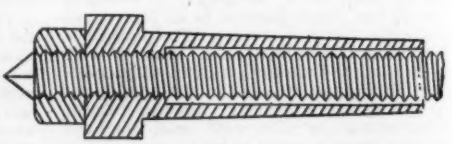


FIG. 2.
SPECIAL CHUCK FOR SQUARE CENTRE.

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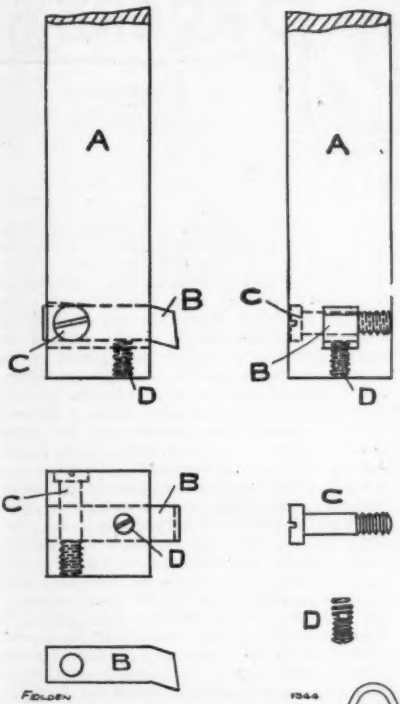
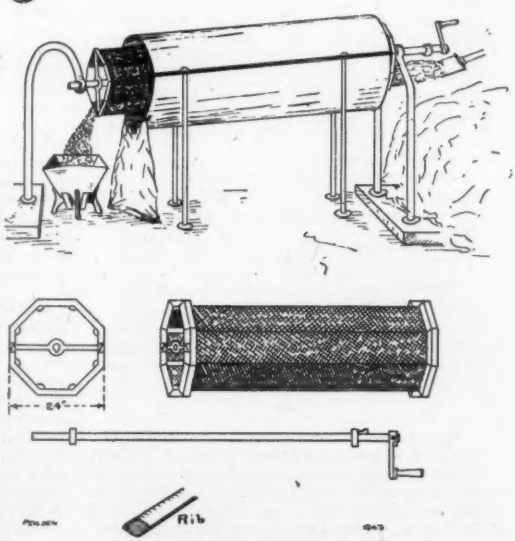


IMPROVED HOLDER FOR SLOTTING MACHINE.

Improved coal dust sifter for Ironfounders.—The sketch shews a simple form of sieve for sifting coal dust in iron foundries, &c., which enables iron founders to reproduce their own coal dust at a nominal cost. Almost any handy man with the blacksmith's assistance could quickly and cheaply make such a contrivance as here described. The upper view shews the sieve in operation, and the lower views the separate parts. It will be seen to consist of an octagonal frame covered with steel gauze, and caused to revolve in suitable bearings in a slanting position. The dust being introduced at the higher end, the finer stuff falls through in its passage down, and is caught in a sack at the lower end of the cover, which surrounds the sieve to prevent the dust flying about. The heavier particles, which do not pass through the mesh, are rejected at the lower end, as shewn. It is advisable to have one or two stops or baffles inside sieve to prevent the passage of dust through same too quickly. A pulley may be substituted for handle where power is available. The octagon ends and ribs are of elm wood, but can be strengthened if required by plates. The sieve portion is 6 ft. long, whilst the cover is 5 ft., but these dimensions can, of course, be adjusted to suit particular requirements, as also the size of mesh, &c.

or centre reamer, I herewith send you particulars of a small chuck I made for taking a square centre. Fig. 1 is a piece of cast steel ½ in. diameter, screwed the full length and formed with as square centre at end. The chuck portion is made from a piece of round mild steel of sufficient diameter to form collar, and the outside should be turned to be a good fit in poppet on loose head and bored out ½ in. dia., tapping about an inch up, and the remaining length half inch clearance. The piece of ½ in. cast-steel is then screwed into shank and locked tight with nut on front face (see Fig. 2). The nut should be adjusted so as to leave as short a working length of centre as possible. Of course, this is not meant to supersede the drill and countersink combined, but only for use in place of an ordinary square centre.



IMROVED COAL DUST SIFTER.

INDUSTRIAL PROGRESS

ENGINEERING NOTES AND COMMERCIAL INFORMATION FROM ALL SOURCES.

Tenders for an Iron Bridge.—The *Lisbon Gazette* of June 6th, contains a notice calling for tenders to be presented up to the 5th of next month (September), for the construction of a metal bridge of a minimum length of 657 metres, over the Tagus, between Gollegã and Chamnsea. The *Gazette*, which may be consulted at the office of the Commercial Intelligence branch of the Board of Trade, 50, Parliament Street, S.W., on any day between the hours of 10 a.m. and 5 p.m., contains a somewhat full statement of what the bridge is required to be, and of the conditions of payment, etc.

Success of the "Meldrum" Furnace.—We gather from the *Sheffield Telegraph* the following interesting information :—Discovering that the Sheffield Gas Company made a considerable quantity of coke dust, which they gave away to builders and others, we entered into a contract for a supply for three years. Having a spare boiler, we had Meldrum's forced draught fitted, and soon discovered that coke dust made a very satisfactory fuel for steam raising. Our second boiler was then fitted, and we are now burning coke dust on the two almost exclusively. From an economical point of view the experiment is very satisfactory, as will be seen from the following figures.

Average week, coal only, on one boiler.

	£	s.	d.
45 tons at 12s. 6d.	28	2	6
Ashes at 2s., seven loads	0	14	0
	£28	16	6

Present consumption on two boilers.

	£	s.	d.
Six tons of coal at 9s. 3d.	2	15	6
Coke dust	3	4	0
Two extra stokers	2	12	0
Flues cleaning	0	10	0
Ashes, 12 loads at 2s.	1	4	0
	£10	5	6

There is no smoke from the chimney stack of the *Telegraph* office, which is another good point in favour of coke dust as fuel.

Agricultural Implements Demanded.—The British Commercial Agent in Russia, in a report to the Foreign Office, states that according to the *Commercial and Industrial Gazette* of St. Petersburg, the trade in agricultural implements at Rostoff, on the Don, is very brisk this year. The turnover last year in the district mentioned reached 6,000,000 roubles, of which 2,000,000 were for foreign-made articles. While the *Moscow Gazette* of June 4th says that there has been a general complaint that agricultural machinery, such as is in general use, either quickly spoils, or cannot be repaired at all, owing to the unsuitability or bad make of the machinery itself ; the *Warsaw Dnevnik* on the other hand, takes the view that the machinery spoils owing to the ignorance of those who are handling it, and from the bad usage it receives, rather than from any inherent defects. What is now wanted therefore is to teach the people how to use and properly handle such machinery for which the demand is constantly increasing. Owing to the remission or reduction of duties on various classes of agricultural machinery, etc., and the growing requirements, British-made articles will find a good opening. Of great importance is advertising, in Russian only, in Moscow papers and in the local papers of all districts. Such advertisement should be concise and practical, and should be accompanied by illustrations, and should give the prices and weights in Russian equivalents. Local agencies and depôts, moreover, should be established in the likely centres, and permanent exhibitions should be opened in the largest towns. The advertising could easily be arranged through London agencies in connection with Russian advertisement agencies, and catalogues, well illustrated, but in Russian, and if possible, with special reference to Russian requirements, methods, and even prejudices, should be fully distributed, more especially by travellers and agents personally. The articles more likely to command a large sale, are light, portable, inexpensive and less complicated goods.

Machines and Transmitting Belts for Japan.—The United States Acting Consul at Chemnitz, Saxony, states that the increasing use of machines of all kinds in Japanese industries has caused a large import of leather and rubber belts, which, doubtlessly, will advance in succeeding years, as Japan has not, up to this time, taken up the manufacture of these articles. The thriving Japanese industries also offer a good market for the export of boilers, especially tubular boilers, while there exists further a great demand at present for drilling, planing, screw, and thread-cutting machines, and turning lathes.

Machinery for British Columbia.—According to an American contemporary, the Stave Lake Power Company, Ltd., has recently been incorporated in Vancouver, B.C., with a capital of £200,000, and has acquired a waterfall on the Stave River, 42 miles from Vancouver, where power will be generated and transmitted to that city. The company will shortly make expenditures of nearly £100,000 on a new plant, and the quantity of machinery, apparatus, and material, which will be purchased, must necessarily be large. Competition for all the requirements will be principally between Canadian, English, and American manufacturers. Early deliveries, it is stated, will be a prominent feature with the Company in placing contracts. This latter point is one which intending competitors in Great Britain should bear in mind.

The Greatest Hydraulic Undertaking.—The title selected for this paragraph is certainly apt to raise expectation, and perhaps doubt, and yet it is a strictly appropriate heading, and even the greatest expectation will remain behind the facts, for the title selected refers to the gigantic project undertaken by the Consolidated Lake Superior Company, namely the construction of a power canal at Sault Ste. Marie, Mich., U.S.A. The cities of Sault Ste. Marie, Mich., U.S.A., and Sault St. Marie, Ontario, Canada, are situated on either side of the St. Mary's River, which connects Lake Huron and Lake Superior, and through which passes the bulk of the enormous commerce of the Great Lakes. The river at a point opposite the cities has an enormous fall, by means of rapids, and it was to obviate this obstacle to navigation that both the United States and the Canadian Government expended millions of dollars in the construction of a number of canal locks, one of which, according to the *Scientific American*—from which the facts contained in this paragraph are taken—is the largest in the world. All that has been said regarding the possibilities of Niagara Falls, applies with even greater force to Sault Ste. Marie. A water power canal, half a mile in length is already in operation on the Canadian side, and another, one mile and a half in length, is under construction on the American side, and is being built to supply a row of mills upon its banks more than a mile in length, and to give each a fall of water of 18 ft., and an ample quantity. In fact the whole project aims at turning the two cities into one great water-mill, with Lake Superior, as was aptly remarked, as a mill pond. That the promoters of the enterprise have vast aims in view appears from the fact that the same capitalists that are constructing the power canal are also building a great railroad from Sault Ste. Marie to Hudson's Bay, tapping unlimited natural resources, including vast deposits of iron, nickel, and copper. The history of the undertaking is in itself full of startling facts. The syndicate of capitalists responsible for the hydraulic improvements of Sault Ste. Marie first acquired a right of way on the Canadian side of the river. The Lake Superior Power Canal Company was then formed and built a power canal, which developed 20,000 h.p. From this parent company grew out, on the Canadian side, the Sault Ste. Mary Pulp and Paper Company, which operates the largest pulp mills in the world, and other manufacturing corporations, while on the American side, the Michigan Lake Superior Power Company came into being for the purpose of developing the water power on that side of the river. During the past year, the Consolidated Lake Superior Company with a capital of $20,000,000 was formed to absorb all the original companies. Connected with this was the incorporation of the American Alkali Company with a capital of $30,000,000 for the manufacture of chemicals by electrolytic methods, for which it will obtain power from the Power Company. The power to be developed from the canal under construction on the American side, measured according to the usual rules, will amount to fully 60,000 h.p., which in itself will show the gigantic possibilities of the undertaking.

Sound Transmission.—The *Comptes Rendus* of the French Academy of Science, contains a communication from M. Dussard, in which he points out that the efficiency of electric transmission of sound increases correspondingly to an increase of the number of the microphones enclosed in the resonator box, and is rendered still greater if air is permitted to act on both sides of the membranes. The electro-magnet at the receiving station, according to the writer, should have several faces each actuating a separate diaphragm, and the sound should be collected from both sides of the latter. In this way the intensity of the sound is so increased that it can work a phonograph, and it has been possible by the manner described to record phonographically telephonic communications over several miles of wire. A speech, also, delivered in a remote part of a large building could be taken down and afterwards reproduced in the lecture-room from the phonograph without any sensible loss of intensity.

A Fraud in Steam Tubes.—According to the *Ironmonger* of June 2nd, one of the members of the Manchester Ironmongers' Association, a Mr. Smith, brought a serious allegation against some ironmongers, at a recent meeting of that Society, accusing them of painting gas-tubes and selling them as steam-tubes. It is the recognised practice in the trade to paint steam-tubes red in order to distinguish them easily from gas-tubes, which are left unpainted. The latter, not having to stand a heavy pressure, are, of course, made of lighter metal, and have a correspondingly lower price. The allegation was borne out by several other speakers. If

the charge should turn out to be true, and the *Ironmonger* expresses the fear that at least there is a grave suspicion that this fraud is habitually practised by certain firms, the guilty persons should be held responsible for what is really a crime. The paper adds that especially in the North of England this criminal trick is said not to be uncommon.

Demand for Iron Goods and Machinery.—The *Handel's Museum* of June 21st publishes a digest of various Consular reports recently issued, showing what countries offer a market for the different iron and metal goods and for machinery, from which the following data are extracted: In consequence of the recent rise in the price of copper, old copper, as well as bronze and iron, is in great demand in Turkey, and good prices are paid for used copper utensils of various kinds. About 270,000 kilogrammes of old copper were imported into Dedeagatsch alone in 1899. One of the consequences of the high price which copper fetches —10 piastres per oke—has been that natives are selling their copper vessels and replacing them by imported enamel ironware, so that there is an opening for a considerable trade in the latter with the East. The *Bulletin Commercial* says that in Bulgaria farmers are becoming more and more accustomed to the use of agricultural machines, and, as the coming harvest promises to be a good one, Bulgaria should prove a good market for the exports of such goods. According to the French Consul at Lanarka, the importation of agricultural machines into Cyprus is rapidly increasing; especially olive presses are in great demand.

The Chappé Industry on the Continent.—It will interest our readers that, notwithstanding the small number of manufacturers engaged in the spinning of silk-waste into chappé, or spun silk yarns, there seems to be a good deal of money in this branch of industry, as may be seen from the statistics of the last few years, showing the amount of capital invested and the profits obtained. Thus, for instance, the Société Anonyme des Filatures de Chappé, of Lyons, made in 1896 a net profit of £140,000, somewhat less in 1897, and over £156,000 in 1898. This latter amount, the capital invested being £480,000, represents an annual profit of over 31½ per cent. The Chappé Spinning Society of Basle, Switzerland, with a capital of £360,000, made in 1897 a net profit of over £112,000, and almost the same in 1898, representing over 31 per cent. of the capital. And, to mention one more instance, in order to show the prosperity of the industry, the shares of the Italian Society for spinning chappé, which were quoted at 160 lire in 1896, are being quoted now at 475 lire.

Electricity for Haulage in Mines.—Mr. D. C. Thomas, in a paper read before the Ohio Institute of Mining Engineers, discussed the practical points of electrical haulage in mines. Speaking of the weight of the locomotive which should be used—which, as he remarks, is intimately connected with the maximum grade and the weight of the load to be transported—he states that practical trials have demonstrated that a ten-ton locomotive going at the rate of from six to eight miles an hour hauls 18 loaded trucks up a two per cent. grade, the trucks weighing 11¾ cwts. and holding 36 cwts. of coal. Mr. Thomas recommends the use of a 30 lb. rail with this size of locomotive, and suggests that the radius of the smallest curve in the track should not be less than 25 ft. He gives a very practical hint for ascertaining, in a very simple manner, whether this degree of curvature is not exceeded, which is to use a straight-edge, ten feet long, laid against the inner side of the rail and to see that the distance between the middle mark of the straight-edge and the rail is not more than 6 inches; the super-elevation of the outer rail should be equal to one-third of the distance between the middle mark of the straight-edge when placed, as above, on the rail. As regards current, he advises that no voltage higher than 250 should be used in mines where there is no firedamp. And speaking of electric haulage as such, Mr. Thomas considers it far superior to both steam and rope haulage, on account of its great convenience as well as on account of the fact that extensions can more easily be made by this than by any other method.

A Popular Employer.—In these days of strikes and discontent it is pleasant to learn of the harmony which exists between Councillor H. C. Longsdon, Mayor of Keighley, and his employees, and which has found expression in the fact that the workmen of Messrs. W. Summerscales and Sons, Ltd., washing machine makers and laundry engineers, of which firm the Mayor is managing director, presented to him on June 22nd an illuminated address, couched in terms of the deepest affection and esteem, accompanied by an oil-painting of their beloved employer. Such examples of mutual attachment between master and men have grown rarer and rarer in modern times, and deserve therefore the more to be noticed, in the hope that they may spur others to emulation.

American Success at the Paris Exhibition.—It appears from the New York *Journal of Commerce* that, whatever other exhibitors may have to say, the manufacturers of the United States have succeeded in making a success of this new opportunity of advertising their products. With their natural gift of pushing trade they have adopted a system of registering the names and addresses of such visitors as may become customers and they have for this purpose invited those who saw their exhibits and machinery in operation, to register in

books specially prepared for the purpose. The Chicago Pneumatic Tool Company, for instance, declare that they have sold at the Exhibition itself manufactures the total value of which will not fall short of half a million dollars. Other American concerns having specialities for sale seem to anticipate a similar return judging from the interest shown by their foreign visitors and the trade between the United States and France, according to the journal above referred to, continues to be above the average

Severe Criticism of Trans-Siberian Railway. — Coming from so noteworthy an authority as Mr. C. A. Moreing, President of the Institution of Mining and Metallurgy, who has made the whole journey from East to West, over the above-named railway in its present condition, the criticism contained in a contribution by him published in the *Finanz Chronik*, deserves attention, although it appears to be somewhat pessimistic in tone. We quote from it the following: "I have just returned from Peking by the Siberian route. I spent several months in Peking, Tientsin, Manchuria, Port Arthur and Corea. I left Shanghai for London on the 12th May and travelled by steamer to Vladivostock, and from thence to Moscow, *viâ* the Amur River and the Siberian Railway. The journey from Shanghai to London by this route occupied 51 days. Baron von Goltz, the first Secretary of the German Legation at Peking, accompanied our party. The journey through Siberia was slow, monotonous, and uncomfortable to the last degree. We found the Siberian Railway in a very bad state, badly constructed, with very heavy gradients, sharp curves, light rails, and generally in an inefficient condition —in fact, in its present state, the Siberian route, as a means of communication from the Far East, is quite impracticable. No doubt in a couple of years' time, when the Chinese Eastern Railway's connections through Manchuria have been completed to Dalni, a great improvement will take place, but even then it will be a precarious and uncomfortable journey for many years to come. Europeans who left Peking the day after me were assaulted on their way out of the gates, but no one anticipated the present terrible state of affairs."

Iron and Stop Valves.—Messrs. Gaukroger Sykes & Roberts, Ltd., Halifax, are offering a surplus stock of Iron Stop Valves, together with a quantity of gun metal steam fittings, gland taps, plug taps, &c. Having put down one of the most modern plants, the production of these fittings is somewhat over reaching the sales, thus the surplus stock. The whole of the fittings are quite new and of recent make and are all of standard pattern.

An Elegant Footbridge over the Spree.— The viaduct referred to crosses the Spree at Oberschöneweide and is a fine example of artistic work at low cost. It crosses a water way of 172 metres, divided by three spans, the middle one having a width of 86 metres, and each of the end spans being 43 metres in width. The free height between the floor and the normal level of the water is 4·10 metres at the ends and 9·70 metres at the middle of the bridge. Next to the pins the clear height for navigation is about eight metres. From a structural point of view it is a combination of the cantilever truss with the arch; all parts of the bridge are of structural steel, the metal floor being built of mild steel. The admissible stress is 12 kilogrammes per square millimetre for an overload of 500 kilogrammes per square metre, which amounts to 14 kilogrammes per square millimetre when the wind pressure (125 killogrammes per square metre) is taken into consideration. The weight of the metal structure of this bridge, which is extremely elegant in appearance, amounts to 160 tons or 930 kilogrammes per level metre, and the total cost of the work, including accessory work, was £55,000.

Chester Sewage Scheme.—We are informed that an important Local Government Board inquiry was held on the 13th inst., by General H. D. Crozier, R.E., into an application of the Chester Town Council for a loan for the purpose of sewage disposal. The Engineer, Major H. Tulloch, C.B., R.E.—past engineer-in-chief to the Local Government Board—described the scheme in detail, stating that it was an absolute necessity to pump the sewage. In answer to Alderman Churton, Major Tulloch said he had no doubt that his scheme was absolutely the best, because they would get a better effluent than by any other system. Mr. Charles J. Lomax, civil engineer, of Manchester, said he had carried out a considerable number of works of a similar character, and having considered the present scheme, he was of opinion that it was as perfect as modern science could make it. No other system could produce the same effluent. Mr. Hibbert, Alderman of Chorley Town Council, and a member of the Ribble Joint Committee, described the works of a similar system of Polarite filters at Chorley. The scheme of Chester, he said, was an improvement on the one for Chorley, and he would not hesitate to say that if it was properly managed it would be almost possible to produce by such means drinking water. When the Royal Committee visited Chorley, he added, Sir Richard Thorne told him that so far as the treatment of domestic sewage was concerned they at Chorley had solved the problem. Mr. Reginald Arthur Tatton, C.E., chief inspector of the Mersey and Irwell Joint Committee, Dr. Carter Bell and the city engineer, expressed themselves in terms of similar approbation. We may congratulate Chester, therefore, upon its prospects of obtaining a model filtration plant, which, let us hope, will find many imitators.

In this section is presented every month a concise precis of the contents of the leading organs of the technical press and of the proceedings of learned societies throughout Great Britain, the Continent, and America, and also, in a summarized form, the subject matter of the more important articles appearing therein.

This systematic record should prove of the greatest value to those of our readers interested in one or more specific sections of technology, trade or economics, or to those who have insufficient leisure to peruse the large number of publications now appearing.

The following is an Index to the abbreviations used throughout the section. It gives an alphabetically-arranged list of the publications regularly reviewed, together with the place of publication and price. Should any of our readers desire further information we shall be happy to supply it.

American Engineer	New York	20c.	*Am. Engr.*
American Machinery	New York	10c.	*Am. Machy.*
American Machinist	New York	6c.	*Am. Mach.*
American Manufacturer & Iron World	Pittsburg	$4 yr.	*Am. Mftr. and Ir. Wld.*
American Shipbuilder	New York	10c.	*Am. Shipbldr*
Annales des Ponts et Chaussées	Paris		*Ann. des Pts. et Chauss.*
Architect	London		*Archt.*
Architectural Record	New York		*Arch. Rcd.*
Architectural Review	Boston U.S.A.	1s.	*Arch. Rev.*
Arms & Explosives	London	6d.	*Arms and Exp.*
Australian Mining Standard	Sydney	6d.	*Aust. Min. Stand.*
Automotor and Horseless Vehicle Journal	London	6d.	*Autom. and Horsel. Veh. Journ.*
Berg und Hüttenmannische Zeitung	Berlin		*Berg Hüttenm. Ztg.*
Board of Trade Journal	London		*Board of Tr. Journ.*
British Architect ...	London	4d.	*Brit. Archt.*
British & Colonial Printer	London	2d.	*Brt. and Col. Prtr.*
British Printer ...	Leicester	1s.	*Br. Prtr.*
Builder	London	4d.	*Bldr.*
Builders' Journal	London	1d.	*Bldr's Journ.*
Bulletin de la Société d'Encouragement	Paris		*Bull. d. l. Soc. d'Encour.*
Canadian Architect	Toronto		*Canad. Archt.*
Canadian Electrical News	Toronto		*Canad. Elec. News.*
Canadian Engineer	Montreal		*Canad. Engr.*
Canadian Manufacturer	Toronto	8s. yr.	*Can. Mftr.*
Canadian Mining Review	Ottawa		*Canad. Min. Rev.*
Carriage Builders' Journal	London	10s. yr.	*Carr. Bldrs'. Journ.*
Chamber of Commerce Journal	London	1s.	*Chamb. of Com. Journ.*
Chemical Trades Journal	Manchester	4d.	*Chem. Trds. Journ.*
Coach Builders' Art Journal	London	25s. yr.	*Coachbldrs'. Art Journ.*
Cold Storage ...	London	6d.	*Cold Storage*
Colliery Guardian	London	6d.	*Coll. Guard.*
Commercial Intelligence	London	1d.	*Com. Int.*
Comptes Rendus de l'Acad. des Sciences	Paris		*Compt. Rend.*
Compte Rendu de la Societé des Ingenieurs Civils	Paris		*Compt. Rend. des Ing. Civ.*
Contract Journal	London	6d.	*Contr. Journ.*
Deutsche Techniker Zeitung	Berlin	9 *mk.* 25 *pf.* yr.	*Deutsch. Techn. Ztg.*
Dingler's Polytechnisches Journal	Stuttgart		*Dingler's Polyt. Journ.*
Diplomatic & Consular Reports	London & Washington		*Dipl. and Cons. Rpts.*
Echo des Mines ...	Paris & Brussels	40 *fr.* yr.	*Ech. d. Mines*
Eclairage Electrique	Paris		*Ecl. Elect.*
Electrical Engineer	London	3d.	*Elec. Engr.*
Electrical Engineering	Chicago		*Elec. Engrg.*
Electrical Review ...	London	4d.	*Elec. Rev.*, London
Electrical Review ...	New York	10c.	*Elec. Rev.*, New York
Electrical World ...	New York	10c.	*Elec. Wld.*
Electrician	London	6d.	*Electn.*
Electricien	Paris		*Electn.*, Paris
Electricity	London	1d.	*Electy.*, London
Electricity	New York	10c.	*Electy.* New York
Elektrochemische Zeitschrift	Berlin		*Elektrochem. Ztschrft.*
Electrotechniker	Vienna	12 *mk.*	*Electrotechniker* yr.
Elektrofechnische Zeitschrift	Berlin		*Elektrotech. Ztschrft.*
Elettricita	Milan		*Elettricita*
Engineer	London	6d.	*Engr.*
Engineer	Cleveland U.S.A.	5c.	*Engr.*, Cleveland
Engineering ...	London	6d.	*Engrg.*
Engineering and Mining Journal	New York	15c.	*Engrg. and Min. Jour.*
Engineering Magazine	New York & London	1s.	*Engrg. Mag.*
Engineering News	New York	15c.	*Engrg. News.*
Engineering Record	New York	12c.	*Engrg. Rcd.*
English Mechanic	London & New York	2d.	*Engl. Mech.*
Gas World	London	6d.	*Gas Wld.*
Gaz, Le	Paris	1 *fr.*	*Gaz*
Génie Civil	Paris	1 *fr.*	*Gén. Civ.*
Gesundheits-Ingenieur	Munchen		*Ges. Ing.*
Glaser's Ann. f. Gewerbe und Bauwesen	Berlin		*Glaser's Ann.*
Hardware, Metals & Machinery	London	5s. yr.	*Hrdw., Mets. and Machy.*
Hardware Trades Journal	London	6d.	*Hrdw., Trds Journ.*
Heating & Ventilating	New York		*Heatng. and Venting.*
Hosiery Trade Journal	Leicester	2s. 6d.	*Hosiery Tr. Jr.*

Ice & Cold Storage	London	6d.	*Ice and Cld. Storage.*
Illustrated Official Journal of Patents	London	6d.	*Ill. Off. Journ. of Pat.*
Indian & Eastern Engineer	Calcutta	R1.	*Ind. and East. Engr.*
Indian Engineering	Calcutta		*Ind. Engrg.*
Industrie Electro Chimique	Paris	60c.	*Ind. Elec. Chim.*
Ingenorum	Copenhagen	2kr. 50ore.	*Ingm.*
Irish Textile Journal	Belfast	11s. 6d. yr.	
Iron Age	New York		*Ir. Age.*
Iron and Coal Trades Review	London	6d.	*Ir. and Coal Trds. Review*
Iron and Steel Trades Journal	London	3d.	*Ir. and Steel Trds. Journ.*
Ironmonger ...	London	6d.	*Irnmgr.*
Journal of the Association of Engineering Societies	Philadelphia	20c.	*Jr. Ass. Eng. Socs.*
Journal of the Chemical Society	London	30s.	*Jrn. Chem. Soc.*
Journal of Commerce	Melbourne	15s.	*Journ. of Comm.*
Journal of Electricity	San Francisco		*Jour. of Elec.*
Journal of Electricity Power and Gas	San Francisco	10c.	*Journ. of Electr. Power and Gas*
Journal of Gas Lighting	London	6d.	*Journ. of Gas Lghting.*
Journal Inst. Elec. Engrs.			
Journal of Royal Inst. of British Architects	London	1s.	*Journ. of Roy. Inst. of Br. Archts.*
Journal of State Medicine	London	2s.	*Journ. of State Med.*
Journal of the Society of Arts	London	6d.	*Journ. of Soc. of Arts*
Knowledge	London	6d.	*Knowl.*
Laundry Journal ...	London	1d.	*Ldry. Journ.*
Laundry Record ...	London	4d.	*Ldry. Rec.*
Lightning	London	2d.	*Lghtng.*
Light Railway and Tramway Journal	London	1s.	*Lt.Ry. & Trmy.Jr.*
Literary World ...	London	1d.	*Lit. Wrld.*
Locomotive Engineering	New York	20c.	*Locom. Engrg.*
Locomotive Magazine	London	2s. 6d. yr.	*Loc. Mag.*
Machinery	London	8s. 6d.	*Machinery,* London
Machinery	New York		*Machinery,* New York.
Machinery Market	London	6d.	*Machf. Mark.*
Manufacturer ...	Philadelphia	$5 yr.	*Mfrr.*
Marine Engineer ...	London	6d.	*Mar. Engr.*
Marine Engineering	New York	6d.	*Mar. Engrg.*
Mechanical Engineer	Manchester	6d.	*Mech. Engr.*
Mechanical Progress	M'chr	3d.	*Mech. Prog.*
Mechanical World	London	1d.	*Mech. Wrld.*
Metallurgie ...	Paris	22fr.	*Metall.*
Miller	London	5d.	*Miller*
Mines and Minerals	Denver	20c.	*Mns. & Mnrls.*
Mining Journal ...	London	6d.	*Min. Journ.*
Mining World ...	London	6d.	*Ming. Wld.*
Mitt. aus d. Kgl. Tech. Versuchsanst	Berlin		*Mitt. a. d. Kgl. Tech. Versuchsanst,* Berlin.
Modern Machinery	Chicago	$1	*Mod. Machy.*
Mois Scientifique	Paris	$1.50	*Mois. Scient.*
Motor Car Journal	London	1d.	*Motor Cr. Jr.*
National Laundry Journal	Chicago	15c.	*Nat. Ldry. Journ.*
Nature	London	6d.	*Nature*
Nature	Paris		*Nature,* Paris
Nautical Gazette ...	New York	10c.	*Naut. Gaz.*
North British Agriculturist	Edinburgh	1d.	*N. B. Agrilt.*
Oest. Monatsschr f. d. Oeff. Baudienst	Vienna		*Oest. Monatsschr. f. d. Oeff. Baudienst*
Oest. Zeitschr. f. Bergund Hüttenwesen	Vienna		*Oest. Zeitschr. f. Berg u. Hüttenwesen.*
Power	New York	10c.	*Power*
Practical Engineer	London	2d.	*Pract. Engr.*
Proceedings, Am. Soc. of Civil Engineers	New York	$6	*Proced. Am. Soc. Civ. Engrs.*
Proceedings of the Engineers' Club of Philadelphia	Philadelphia	$2	*Proced. Engrs. Club*
Public Health Engineer	London	3d.	*Pub. Hlth. Engr.*
Railroad Gazette ...	New York	$6.08	*Rld. Gaz.*
Railway Age... ...	Chicago	10c.	*Ry. Age*
Railway Engineer	London	1s.	*Rail. Engr.*
Railway and Engineering Review	Chicago	$5	*Rail and Engng. Rev.*
Railway Magazine	London	6d.	*Rail. Mag.*
Railway Master Mechanic	Chicago	$1.50	*Railw. Mast. Mech.*
Railway News ...	London	6d.	*Rail. News*
Railway Record ...	London	6d.	*Rail. Rcd.*
Railway Supplies Journal	London	6d.	*Ry. Sup. Jr.*
Revista Minera ...	Madrid	25fr.	*Rev. Min.*
Revue Technique ...	Paris	1fr.	*Rev. Tech.*
Revue de Chimie Industrielle	Paris	15fr.	*Rev. d. Chim. Ind.*
School of Mines Quarterly	New York	50c.	*Sch. Mines Qlly.*
Science Abstracts	London & New York	2s.	*Science Abstr.*
Scientific American	New York	$4 yr.	*Sci. Am.*
Scientific American Supplement	New York	$5 yr.	*Sci. Am. Suppl.*
Shipping World ...	London	6d.	*Shpng. Wrld.*
Shoe Manufacturers Monthly	London	2s.	*Shoe Mfrs. Mthly.*
South Africa ...	London	6d.	*South Afr.*
Stahl und Eisen ...	Dusseldorf	24mk. yr.	*Stahl u. Eisen*
Steamship	Leith	6d.	*Steamsh.*
Stevens' Institute Indicator	New York	50c.	*Stevens' Inst. Ind*
Stone	New York		*Stone*
Street Railway International Journal	New York	50c.	*St. Ry. Inter. Jr.*
Surveyor	London	6d.	*Survr.*
Syren	London	3d.	*Syr.*
Technology Quarterly	Boston	75c.	*Tech. Qlly.*
Textile Industries	Bradford	10s. yr.	*Text. Ind.*
Textile Mercury ...	Manchester	1d.	*Text. Merc.*
Textile Recorder ...	Manchester	12s. yr.	*Text. Rcdr.*
Textile-Zeitung ...	Berlin	16 mk. yr	*Text. Ztg.*
Tramway & Railway World	London	1s. 3d.	*Tramw. and Railw. Wld.*
Transactions of the American Society of Mechanical Engineers	Cincinatti		*Trs.Am.Soc.M.E*
Transactions of the Inst. of Naval Architects	London		*Trs. Inst. Nav. Arch.*
Trans. Inst. Engrs. & Shipbuilders	Glasgow		
Transactions of the N. E. Coast Institution of Engineers and Shipbuilding	Newcastle		*Trs. N. E. Inst. Engrs. and Shpbldrs.*
Trans. Soc. Engrs.			
United Service Magazine	London	2s.	*Un. Ser. Mag.*
Western Electrician	Chicago	10c.	*West. Electn.*
Zeitschr. d. Oest. Ing. u. Arch. Vdr.	Vienna	30 fr. yr.	*Ztschrft. d. Oest. Ing. u.. Arch. Ver.*
Zeitschr d. Ver. Deutscher Ingen.	Berlin		*Ztschrft. d. Ver. Deutsch. Ing.*
Zeitschrift für Halle a. S. Elektrochemie		16 mk. yr.	*Ztschrft. f. Elektrochem.*
Zeitschrift für Halle a. S. Elektrotechnik			*Ztschrft. Elektrotech.*

ARCHITECTURE AND BUILDING.

1. Construction and Design.

Expanded Metal.—*Experiment with a Concrete and Expanded Metal Structure.* The article describes the results of an experiment with what the French call "béton armé," contained in a report by Mr. A. Baker, of Beckton, submitted to the Institution of Gas Engineers at London. 1½ cols.—*Revue Technique*, May 25th, 1900.

Iron Construction.—*The Newark Armoury Drill Hall.* Description of the First Regiment National Guard Armoury, N.Y., U.S.A., the frame work of which is entirely of steel, with seven main roof trusses, about 26 feet apart and two 45 degree h.p. trusses. (Ill.) 3 cols.—*Engng. Rcd.*, May 26th, 1900.

2. Heating and Ventilation.

Heating and Ventilation.—*Ventilating and Heating the City Hospital, Albany.* Description of an interesting example of a large one-pipe system of heating by direct-indirect radiation, with a natural system of ventilation represented by the recently completed plant for the City Hospital at Albany, N.Y., U.S.A. 3 cols.—*Engng. Rcd.*, May 26th, 1900.

Steam Heating Plant.—*Heating of the Indian School, Genoa, Nebraska.* Comments on an interesting one-pipe steam-heating plant for detached buildings with the steam supply from a central so rce which was installed during the winter of 1898-99 in the Indian Industrial hool at Genoa, Nebraska, U.S.A. 1⅝ col.—*Engng. d.*, June 2nd, 1900.

Ventilating and Heating.—*Ventilation and Heating of the Law School Building, University of Pennsylvania.* Description of a very interesting plant installed last year, by means of which the building is warmed, largely by a heated supply of fresh air, and circulation is maintained by the plenum system. (Ill.) 5 cols.—*Engng. Rcd.*, June 16th, 1900.

—— *An English System of Hospital Warming and Ventilation.* Comments on a paper by Mr. T. Wilson Aldwinckle, read before the Architectural Association of London and the suggestions made by the author regarding the ventilation of hospitals. The author of the comments points out the difference between American and English practice, owing to the difference of climate. 1½ col.—*Engng. Rcd.*, June 2nd, 1900.

3. Plumbing and Gasfitting.

4. Miscellaneous.

Building.—*The House in the Twentieth Century. I.* The author begins with a short historical review of the builders' art in Europe from the earliest times to our own, discusses the hygienic conditions of dwellings and dwells on the advantages of iron structures and of the important part played by cement. (To be continued). 6⅝ cols.—*Revue Technique*, May 23rd, 1900.

CIVIL ENGINEERING.

1. Bridges.

Bridges.—*Concrete Steel Construction in the Proposed Memorial Bridge.* The article refers to the construction of a memorial bridge across the Potomac River at Washington from a design by Prof. Burr, which provides for six granite masonry arches with concrete steel sheeting, 192 feet each in the clear springing joints. (Ill.) 1½ col.—*Engng. Rcd.*, May 26th, 1900.

—— *Rolling-Lift Bridge over Fort Point Channel, Boston.* Description of a bridge which forms part of the extensive works that have been necessary in connection with the approaches of the various roads which enter into the South Terminal Station at Boston. (Ill.) 1½ col.—*Sci. Am.*, June 16th, 1900.

—— *Foot Bridge across the Seine between the Pont de l'Alma and the Pont de Iéna.* Description of one of a number of temporary bridges erected by the Exhibition Commissioners in order to provide for the extra traffic caused by the multitude of visitors to the Exposition. The author of the article, M. Ch. Danton, enters fully into the structural details of this interesting engineering work, executed with great success and in spite of numerous obstacles by MM. Daydé and Pillé, of Paris. (Ill.) 8½ cols.—*Gén. Civil*, May 26th, 1900.

Bridges.—*Eight Track Rolling Lift Drawbridge over the Chicago Drainage Canal.* Description of the largest and most important of the bridges across the Chicago Drainage Canal which is to form a link in the navigable water way between the great lakes and the Mississippi. The bridge will be of the Scherzer rolling-lift bascule type and will be located just west of Campbell Avenue, in the city of Chicago, where the canal is crossed by three railways with eight parallel tracks all close together. The Trustees of the Drainage Board agreed to build this bridge of a design approved of by the railways, and also to pay to the railways a sum of money of which the interest will suffice to pay the expenses of maintenance and operation of the bridge. (Ill.) 4 cols.—*Engng. News*, May 24th, 1900.

—— *A.* 128.—*Foot plate-girder Railroad Bridge.* Description of Bridge, No. 7, of the Bradford division of the Erie Railroad, being a single track through plate-girder structure, with a sheer of 9 ft. 5½ in. in the width and 16 ft. 9in. between centres of girders. There are two main girders, 9½ ft. deep and 128½ ft. long over all, which have a minimum clear span of 120 ft. between abutments below the coping, and of 125 ft. 2½ in. between centres of bearings. 4½ cols.—*Engng. Rcd.*, June 16th, 1900.

2. Canals, Rivers and Harbours.

Dredges.—*Self-Propelling Hydraulic Dredge for the Mississippi River.* Account of a dredge with propelling machinery attached, to be called the *Iota* and now being built for the Mississippi River Commission; it will be a steel hulled vessel fitted with side wheels hanging a length (molded) of 192 ft., and a width (molded) of 44 ft. with 4 ft. draft and a depth of 7 ft. 4½ cols.—*Engng. News*, May 31st, 1900.

—— *Deep Sea Dredges and Dredging.* Description of a number of modern dredges, some of them dumping and dredging 9,000 tons of sand a day, most of them constructed in Great Britain, models of which figure prominently in the Paris Exposition. (Ill.) 2¾ cols.—*Am. Mfgr.*, May 24th, 1900.

3. Irrigation.

4. Road Building.

Road Building.—*Good Roads.* Comments on a paper by Mr. A. Moresby White, F.R.G.S., read before the Society of Arts, summarising the present condition of roads and road-building in England and suggesting some very necessary improvements which the author believes ought to be and will be inaugurated in the near future 1¼ col.—*Automotor*, June 15th, 1900.

ELECTRICAL ENGINEERING.

1. Electro-Chemistry.

Accumulators.—*The Construction of Electric Accumulators.* The article contains a short history of the invention and development of the construction of secondary batteries and gives a popular outline of the chemical phenomena underlying their manufacture. 3½ cols.—*Automotor Journ.*, June, 1900.

Electrical Chemistry.—*Advancement of Electrical Chemistry.* By Mollwo Perkin. The author shows that although electro-chemistry is quite in its childhood, it is making marvellous and rapid progress, and that books on the subject, but a few years old, require entire revision; he adds that it is humiliating to think that there hardly exists any satisfactory treatise on Electro-Chemistry published in England, and that even those that exist are translations from continental works. 3½ cols.—*Nature*, June 7th, 1900.

Electro-Chemistry.—*The Manufacture of Alcohol from Acetylene.* Description of a method devised by M. Villon and described by Dr. Geo. N. Benjamin, who states that ethyl-alcohol is largely used in Russia as fuel for motor vehicles, being made by this process at a cost of only 8 cts. per gallon.

Electrolysis.—*The Theory of Electrolytic Dissociation* Review of an important volume on this theory which, though only fifteen years old, has been the subject of considerable scientific research. The author himself, Mr. H. C. Jones, has contributed much to establish this theory on a firm basis, which renders his work the more noteworthy. 4 cols.—*Nature*, June 7th, 1900.

Electrolysis.—*An Electrolytic Centrifugal Process for the Production of Copper Tubes.* (Continuation.) Description of a centrifugal process, devised by the author, which is now being worked on a practical scale, for copper refining and the manufacture of copper tubes, etc., by electro-deposition. (Ill.) 2 cols.—*Electro-Chem. Rev.*, May, 1900.

—— *Electrolytic Processes.* By Dr. D. Tomassi. The author after giving a general outline of the essential features of electrolysis, describes a process invented by him for treating argentiferous lead, which is applicable also to argentiferous copper pyrites, blendes and other argentiferous minerals and to many other important purposes, the preparation of spongy lead for instance, for accumulators. 6 cols. *Mod. Machy.*, June, 1900.

—— *An Electrolytic Process for the Manufacture of Parabolic Reflectors for Search-Lights and Locomotive Head-lights.* By Sherard Cowper-Coles. The present instalment deals with the conditions necessary to obtain a parallel beam of light, the difficulties in producing true metallic reflectors, the history of the various attempts to solve the problem, and the details of the process invented by the author himself, one of the chief features of which is that the surface produced requires no after polishing or trueing up. (Ill.) 2¼ cols.—*Electro-Chem. Rev.*, June, 1900.

—— *Conditions of Electrolytic Corrosion in Brooklyn.* By Dr. Samuel Sheldon. Description of the electrolytic effect of a system of electric tramways to which are supplied about 47,000 amperes, for the driving of 1,100 cars. 5 cols.—*Elec. Rev.* (New York), June 6th, 1900.

—— *Conditions of Electrolytic Corrosion in Brooklyn.* By Samuel Sheldon. Abstract of a paper read before the Am. Instit. of Elec. Engrs. The author describes the electrolytic effects of the surface trolley tracks in the city named, which are supplied with current from seven power stations with about 47,000 amperes. 2¾ cols.—*Elec. Wrld. and Engr.*, June 9th, 1900.

2. Electric Lighting.

Arc Lamps.—*Report of the National Electric Light Association Committee on the Photometric Value of Arc Lamps.* Digest of the report of a committee consisting of Messrs. Henry L. Doherty, W. E. Goldsborough and J. A. Brown, who witnessed the photometric experiments performed by Prof. C. P. Mathews in the excellent laboratory of Purden University, Lafayette, Ind. (Ill.) 3¾ cols.—*Elec. Wrld. and Engr.*, June 2nd, 1900.

Electric Light.—*Series Enclosed Alternating Arc Lighting for Street Lighting Service.* By Prof. W. L. Robb. Extracts from a paper read at the Chicago convention of the National Electric Light Association, from which it appears that this form of lamp is going to solve to a great extent the feeding of street arc lights from large direct coupled units. 4 cols. and 2¾ cols. respectively.—*Elec. Rev.*, New York, May 23rd and 30th, 1900.

—— *Multiple Series G.I. Enclosed Arc Lamps.* Concise description of a type of lamps for multiple series connection on direct current, constant potential circuits of from 200 to 600 volts, or higher voltage, the only limitations being that each lamp shall have at least 90 volts, and not more than 125 volts at the terminals. (Ill.) 1 col.—*Elec. Wrld. and Engr.*, June 2nd, 1900.

—— *On the Intrinsic Brilliancy of the Crater of the Arc.* By J. E. Pateval. Extract from the Proceedings of the Royal Society, *i.e.*, from a paper on "An Experimental Research on some Standards of Light," by the author, in which he gives the results of his experiments on the subject, coming to the conclusion that the intrinsic brilliancy of the crater of a silent arc is about 147 c.p. per square millimetre, that variations in the size of the carbons, in the intensity and density of the current, in the length of the arc, and in the total power expended will not cause the intrinsic brilliancy to vary more than 10% on either side of the mean, etc. (Ill.) 3½ cols.—*Elec. Engr.*, June 8th, 1900.

—— *The Electric Light Plant of Malta.* By R. H. Ashcroft. Description of a plant put into operation December 1st, 1896, and which has been running continually ever since; the entire work of installation having been carried out by the British Electrical Engineering Company of London, England. (Ill.) 1½ col.—*Elec. Wrld. and Engr.*, May 26th, 1900.

Electric Light.—*Elements of Illumination. III.*—By Dr. Louis Bell. The present instalment contains some general directions regarding the best direction of illumination, the strength of illumination required for various kinds of work, and a discussion of the relation of colour to practical illuminations. (Ill.) 3½ cols.—*Elec. Wrld. and Engr.*, May 26th, 1900.

—— *Elements of Illumination. IV.*—By Dr. Louis Bell. This instalment contains a continuation of the discussion of the relation of colour to illumination, and the author points out the importance of the study of colour effects produced by coloured illuminations, and shows, moreover, that the general colour of the illumination in a given plan depends also upon the colour of the surroundings. 3¾ cols. *Elec. Wrld. and Engr.*, June 9th, 1900.

—— *Carlisle Electric Lighting.*—By Charles D. Burnet, A.I.E.E. Abstract of a paper read before the Incorporated Association of Municipal and County Engineers at Carlisle, on May 26th. Description of a plant designed by Prof. Kennedy, for a low tension three wire direct current supply. (Ill.) 3¾ cols.—*Elec. Engr.*, June 8th, 1900.

—— *A Complete Series Alternating Enclosed Arc System.* Description of some details of the Manhattan General Construction Company's System, as manufactured at its factory in Newark, N.J., which seems to solve in a satisfactory manner the problem of arc lighting distribution from direct coupled units. (Ill.) 1 col.—*Elec. Rev.* (New York), May 23rd, 1900.

—— *English County Houses Electrically Equipped.* By Frank C. Perkins. The author speaks with appreciation of the progress made as regards electric lighting in British country houses, and, in support, describes several plants laid down by Messrs. Scott and Mountain, Newcastle-on Tyne. (Ill.) 2 cols.—*Electricity* (New York), June 13th, 1900.

—— *Electric Train Lighting.* By Alton D. Adams. Discussion of the various methods of electric train lighting, and their advantages and drawbacks. 2 cols.—*Electricity* (London), June 8th, 1900.

—— *Waterfield Asylum Electrical Installations.* The article deals with the modern electrical equipment of the West Riding Asylum at Wakefield, consisting of a large group of building covering an area of 25,000 square yards. (Ill.) 4 cols.—*Elec. Rev.* (London), June 15th, 1900.

Incandescent Lamps.—*A Regulator for Single Incandescent Lamps.* Description of a device consisting of a small rheostat located in the canopy of a side wall bracket or a fixture depending from the ceiling, or it may be used in a special separate switch located in any convenient place. 1½ cols.—*Elec. Rev.* (New York), May 3rd, 1900.

3. Power.

Central Station Practice.—*Operating Economies in Central Station Practice.* By W. L. Abbott. Abstract of a paper read before the Electric Light Association at the Chicago meeting, May 22nd, 1900, in which the author communicates various methods, which he believes will result in a saving of expenditure. 8 cols. *Elec. Rev.* (New York), May 30th, 1900.

Dynamos.—*Siemens Dynamos at the Paris Exhibition.* Description of a multi-polar Siemens generator for coupling direct to the Willoms vertical triple expansion engine, having an output of 2,050 h.p., 2,780 ampires at 550 volts, which can be exceeded by 20 per cent. for short period. (Ill.) ¾ col.—*Elec. Rev.* (London), June 8th, 1900.

Generators.—*Alternating Current Generators.* By H. G. Reist. Abstract of a paper read at the Chicago Convention of the National Electric Light Association. The author describes the many improvements made in alternating current machines since the introduction of machines with revolving fields. (Ill.) 9 cols.—*Elec. Rev.* (New York), May 23rd, 1900.

Electric Plant.—*Electric Power-House of the "Three Phase" Company at Asnières, near Paris.* By L. Moriès. Description of a large Central Station in course of construction by the above-named Company to supply current for light and power. 11½ cols.—*Génie Civil*, June 9th, 1900.

—— *The Polyphase Distributing System of the Metropolitan Street Railway Company of New York City. VII.* By J. E. Woodbridge. The present instalment deals with the sub-station high-tension circuits, the six-phase connections, etc. (Ill.) 3 cols.—*Elec. Wrld. and Engr.*, June 2nd, 1900.

Electric Plant.—*The Polyphase Distributing System of the Metropolitan Street Railway Company, New York City. VIII.* By J. E. Woodbridge. (Conclusion.) This instalment concludes the contribution with a description of rotary convertors, and the direct current circuits. (Ill.) 2¼ cols. —*Elec. Wrld. and Engr.*, June 9th, 1900.

—— *Central Station in the South. I.* Description of the very complete modern plant of the Montgomery Light and Power Company, at Montgomery, the capital of Alabama, U.S.A., which supplies all the electricity for illuminating the streets, public and private buildings, and furnishes, besides, the power for the two electric street railway companies. (Ill.) 2¼ cols.—*Elec. Wrld. and Engr.*, June 9th, 1900.

—— *Central Stations in the South. II.* By W. S. Key. Description of the electric plants in Birmingham, Alabama, U.S.A., *i.e.*, that of a million dollar steel plant of the Tennessee Coal, Iron, and Railroad Company, in the suburb of Eresby, and the plant of the Consolidated Electric Light Company. (Ill.) 2 cols.—*Elec. Wrld. and Engr.*, June 16th, 1900.

—— *City of New York Electricity Works.* Description of a plant erected from specifications drawn up in 1896, by Prof. Kennedy, the construction being commenced in October, 1898, and approaching completion. (Ill.) 3 cols. —*Lighting*, June 14th, 1900.

—— *The Electric Plant of the Parkgate Steel Works.* The article gives a full description of the electrical equipment of the Parkgate Works, situated some six miles from Sheffield, and covering 40 acres of ground, comprising blast furnaces, basic steel works and rolling mills. 5 cols.—*Iron and Coal Trds. Rev.*, June 22nd, 1900.

—— *New Power Station of the Third Avenue Railway Company of New York.* The article describes in detail the Power Station in 21st Street and Ninth Avenue, New York, in course of construction, which promises to be the largest in the world, and which will supply 100,000 horse-power. (Ill.) 6 cols.—*Revue Technique*, June 10th, 1900.

—— *The Jacques-Cartier Water Power Company.* Description of a plant recently erected by the International Hydraulic Company, for the Jacques-Cartier Power Company, the power station of which is situated at St. Gabriel, P.Q., Dominion of Canada, where there is a fall of 20 ft., in the St. Gabriel River, which occurs in a rapid 200 yards in length; at the head of the rapids a dam 300 ft. long has been erected, 270 ft. below which, in a depression near the river, stand the power-house, containing two 750-ton Westinghouse three-phase alternating-current generators, direct-connected to S. Morgan Smith waterwheels; the generators are wound for 2,000 volts, with a frequency of 7,200 alternations at a speed of 150 revolutions per minute. The electric energy is transmitted to Quebec, 18 miles distant. 1¼ cols.—*Elec. Wrld. and Engr.*, June 9th, 1900.

—— *Pike's Peak Company's Power Plant.* By J. W. Dickinson. Description of one of the most interesting enterprises of power transmission in the Rocky Mountain region, *i.e.*, that of the Pike's Peak Power Co., of Victor, Colorado, for which a dam is being constructed near the confluence of the Beaver Creeks, a few miles from Cripple Creek, which will be the largest steel-faced, granite, back-filled dam in the United States. (Ill.) 5 cols.—*Mod. Machy.*, June, 1900.

Electric Transmission.—*Electric Transmission in Factories and Mills.* By William S. Aldrich. Abstract of a paper presented to the Cincinnati meeting, May, 1900, of the Am. Soc. of Mech. Engrs. The author compares electric, steam, compressed air, and hydraulic transmission, and decides in favour of the latter, 5½ and 4½ cols. respectively.—*Mech. Engr.*, June 9th and 16th, 1900.

Gigantic Hydraulic Plant.—*The Sault Power Canal.* The construction of a power-canal at Sault St. Mary, Michigan, in progress by the Consolidated Lake Superior Company, is the largest hydraulic undertaking so far inaugurated in the United States. The physical energy to be developed by this canal, on the American side, will amount to fully 60,000 h.p. The article gives a concise description of the importance and main features of the enterprise. (Ill.) 3 cols.—*Sci. Am.*, May 26th, 1900.

Power Transmission. — *Niagara's Power. How Energy is now developed from America's great Water-fall.* Concise description of the interesting power plant and the work done by its utilisation at Buffalo, and other localities at considerable distance from the Falls. 1¼ col. *Am. Mftr.*, June 1st, 1900.

—— *Long Distance Electric Power Transmission.* Abstract of a paper by Prof. George Forbes, F.R.S., read before the Institution of Electrical Engrs. (Conclusion.) This final instalment deals with the Niagara Falls Power Plant, the Transmission Line to Buffalo, Connection Factors and Phase Rectifiers, Overhead Conductors, and Aluminium Conductors. 6 cols.—*Mech. Engr.*, June 9th, 1900.

Road Traction.—*The Motor Wagon for Heavy Duty.* Abstract of a paper by Arthur Herschman, read before the Cincinnati meeting of the Am. Soc. of Mech. Engrs., in which the author discusses modern types of motor wagons for heavy duty, and comes to the conclusion that the motor wagons in the near future will oust the horse-drawn truck. 3 cols.—*Engrg. News.*, May 24th, 1900.

4. Telegraphy and Telephony.

Cableways. — *Recent Cableway Installations.* The article deals with the Lidgerwood cableway for the construction of fortifications for the United States Government, the use of which in these cases is considered a new application of this system of machinery. 2⅜ cols. *Engrg. Rev.*, May 26th, 1900.

Coherer.—*An Automatic Coherer.* Description of a coherer devised by M. Tommasino with the object of having the agglomeration of the particles cease immediately after the action of the electric wave; this coherer acts instantaneously, and is small enough to be contained in an ordinary telephone receiver. ⅜ col. —*Sci. Am.*, June 16th, 1900.

Submarine Cables.—*Regarding Submarine Telegraphy.* By J. Thoulet. The author, after some general remarks on the importance of ownership of cables for all great Powers, dwells on the necessity of a careful study of the ocean bed, and draws attention to British work in this direction, and its absence in France.—*Le Yacht*, May 19th, 1900.

Telephony. — *Dr. Pupin's Improvements in Long Distance Telephony.* Description of a method arrived at by Dr. Pupin after a series of experiments made in Columbia University, for the construction of long distance electric cal conductors, involving a radical but simple change-by which the efficiency of transmission of electrical energy is greatly increased, and many of the chief difficulties in the way of accelerating long distance messages may be overcome. 4 cols.—*Sci. Am.*, June 2nd, 1900.

Telegraphy.—*A French Multiplex Telegraphy System.* Digest of a note from M. E. Mercadier, presented by M. Cornu to the French Academy of Sciences, on March 19th, describing a recent invention for the simultaneous transmission and receipt of 24 telegrams on a single line. (Ill.) ⅜ cols.—*Electricity* (London), June 21st, 1900.

5. Miscellaneous.

Electric Conductors.—*The Use of Aluminium Line-Wire and some Constants.* By F. A. C. Perrine and F. G. Baum. Abstract of a paper read at the seventeenth general meeting of the American Institute of Electrical Engineers, Philadelphia, May 16th, 1900, in which the authors describe the results obtained with aluminium conductors over a line of 43 miles. 5¼ cols. *Electricity* (New York), May 30th, 1900.

—— *The Use of Aluminium Line-Wire and some Constants for Transmission Lines.* By F. A. C. Perrine and F. G. Baum. Abstract of a paper read at the seventeenth general meeting of the American Institute of Electrical Engineers, Philadelphia, May 16th, 1900. The authors have carefully studied the properties of aluminium and its suitability for electric conductors, during an experiment carried on over a line 43 miles in length, running through a country which varies in elevation from about 100 ft. above sea-level to at least 2,000 ft., and in the present article describe the results, having come to the conclusion that aluminium can safely be used in place of copper, when the proper precautions are taken of inspecting the wire ere it is erected and due attention is paid to its peculiar properties of low and indefinite elastic limit and active electrolytic power. 4¼ cols. *Elec. Wrld. and Engr.*, June 9th, 1900.

Electric Conductors.—*Telephony over Cables and Long Distance Air Lines.* By Dr. M. J. Pupin. Abstract of a paper read before the American Institute of Electrical Engineers Philadelphia, May 18th 1900, in which the author describes a method of constructing cables and long-distance air-lines for power-transmission by electric waves, particularly for long distance telephony and telegraphy. 8¾ cols. and 7 cols. respectively. *Elec. Rev.* (New York), May 23rd and 30th, 1900.

—— *The Possibility of Trans-Atlantic Telephony.* This is an interview with Dr. M. J. Pupin on his new system of cable construction, in which the inventor says that although by his system telephonic messages might be conveyed across the Atlantic, the real value of his system consists in enormously enhancing the capacity of cables for telegraphic messages. 1¾ col. *Elec. Rev.* (New York), June 6th, 1900.

Electric Apparatus.—*The New Edison Building in Chicago.* Description of the new sumptuous premises of the Chicago Edison Company, at 139, Adams Street of that city, being a reconstruction, with additions, of the old building, which, only a few years ago, was supposed to suffice for the requirements of even a rapid growing company. (Ill.) 9½ cols.—*Western Electrician*, May 19th, 1900.

Electric Applications.—*The "Safety" System of Electric Water-tight Doors.* The author dwells on the fact that no modern sea-going steamship would be called safe without being provided with water-tight bulkheads, and describes an electric system for securing the doors, superior to hydraulic and pneumatic systems heretofore in use. (Ill.) 3½ cols.—*Electricity* (New York), June 20th, 1900.

—— *Electric Head-Light Effects.* By D. Allen Willey. The author deals with the advantages of the electric head-light for locomotives which is in extensive use in the Southern States of the American Union, and is being freely adopted in the West. ¾ col.—*Sci. Am.*, June 16th, 1900.

—— *Some Electric Art Features at the Exposition.* Descriptive of the decorative work in the Exposition buildings erected by the Government, and especially on those devoted to electrical exhibits, of which the Palace of Electricity occupies the foremost rank. (Ill.) 2½ cols. —*Elec. World and Engr.*, May 26th, 1900.

Electric Circuit.—*Compensators for Alternating Current Circuits.* Description of what is claimed to be a simple, inexpensive, and thoroughly effective method of maintaining a proper and constant electro-motive force at the point of consumption; this method consists in the use of the compensator, which is made in two types at the Westinghouse Electric and Manufacturing Company: one to compensate for ohmic drop only, the other for both ohmic and induction drop. 3½ cols. *Elec. Review* (New York), May 23rd, 1900.

Electric Curiosity.—*Static Electricity utilised for Engine-room Ornament.* By Howard B. Darley. The author describes a method for using the electricity exhibited by all rapidly moving leather belts for driving a small motor, and gives an outline of such a motor installed in the engine-room of the Advance Thresher Company, of Battle Creek, Mich. (Ill.) 1 col.—*Western Electrician*, June 2nd, 1900.

Electric Distribution.—*One and Two-Wire Systems of Electric Distribution Comparatively Discussed.* By Alton Adams. This is a reproduction of an article on the subject published in the *Electrical Review*, New York. 3½ cols. *Electricity* (London), June 1st, 1900.

—— *Voltage Equalizers for Three-Wire Systems.* Extract from a paper on the subject by F. S. Hickok, published in the *Western Electrician*, in which the author discusses the various methods that have been tried in order to secure the advantages of the well-known three-wire system. 1½ col. and 4½ cols. respectively.—*Electricity* (London), June 8th and 15th, 1900.

Electric Engineering Industry.—*The German Electrical Engineering Industry in 1899.* By John B. C. Kershaw. Following the custom initiated last year, the writer has again abstracted the reports and accounts of the leading German electrical engineering firms, as they have appeared from time to time in the columns of the *Elektrotechnische Zeitschrift* of Berlin. 3 cols. and 3½ cols. respectively.—*Lightning*, June 7th and 14th, 1900.

Electrical Exhibits.—*The Paris Exhibition.* An article on some of the electrical exhibits in the Paris Exposition, chosen at random by the author, who justly remarks that it is quite impossible to treat of the whole unless in a bulky volume, and that even an adequate description of the most important exhibits is beyond the limits of a weekly paper. (Ill.) 5 cols.—*Elec. Engr.*, June 15th, 1900.

Electric Machinery.—*At the Paris Exposition.* The author describes the Champs de Mars Electrical Power Stations during a visit to the Exhibition, when all the exhibits were still in a very unfinished condition. (Ill.) 5 cols.—*Elec. Wrld. and Engr.*, June 2nd, 1900.

Electric Manufacturing Companies.—*The New York Works of the Western Electric Company.* The Western Electric Company, which exclusively manufactures the tremendous amount of apparatus used by Bell telephone exchanges throughout the United States, has had heretofore great works both in Chicago and in New York City. These works having become insufficient, a new factory has been in course of construction in New York City for some time, and is rapidly approaching completion. The present article describes the new plant, which is giving work to 8,400 persons, while the Chicago works employ another 5,400; these new works serve almost exclusively for the manufacture of fine apparatus. (Ill.) 4½ cols.—*Elec. Wrld. and Engr.*, June 2nd, 1900.

Electric Supply.—*Electrical Supply by Gas Companies.* By Allen D. Adams. The author dwells on the very great facilities which gas companies have for running electrical plants, since they are able to furnish the power for gas engines at a minimum of expenditure. 2 cols.—*Sci. Am.*, June 16th, 1900.

Electrical Testing.—*The Practical Elements of Electrical Testing.* By J. Warren. The author, in this contribution, has compiled the most useful electrical tests, and describes the manner in which they are practically conducted, together with a summary account of the principal apparatus involved, on the lines of Kempe's "Handbook of Electrical Testing," omitting, however, all theoretical discussion as being a hindrance when prompt reference to the manner of conducting a certain test is necessary. (To be continued.) 1½ cols.—*Electricity* (London), June 22nd, 1900.

Electric Works.—*The English Electric Manufacturing Company's Works.* Description of the above named works at Preston, which though in operation hardly more than a year, have already risen to a most important position. The author describes the site, the buildings, the receiving and shipping tracks, the machine shop, etc. (To be continued.) 3¾ cols.—*Elec. Engr.*, June 22nd, 1900.

—— *The English Electric Manufacturing Company's Works.* (Continuation). This instalment continues the description of this comparatively new but well-equipped and successful British enterprise. (Ill.) 2½ cols.—*Elec. Engr.*, June 29th, 1900.

—— *The English Electric Manufacturing Company's Works at Preston.* General description of this modern and interesting British engineering plant, which promises to offer serious obstacles to foreign competition in electric products. (Ill.) 2½ cols.—*Lightning*, June 21st, 1900.

—— *The English Electric Manufacturing Company's Works.* Description of the enterprise of an organisation inaugurated less than two years ago under the name of Electric Railway and Tramway Carriage Works, Ltd., Preston, and doing at present an excellent and extensive business. 7½ cols.—*Contract Journ.*, June 20th, 1900.

——*The New Works of the English Electric Manufacturing Company, Limited.* This is a descriptive article on the site, equipment, and working of the shops of this young but extraordinarily successful company at Preston. (Ill.) 4 cols. (To be continued.)—*Elec. Rev.* (London), June 22nd, 1900.

—— *Messrs. Ferranti's Hollinwood Works.* (Concluded.) This concluding instalment gives an account of Ferranti's continuous current lighting and traction switching gear, and winds up with a brief reference to the winding and transformer shop at the Hollinwood Works and its products. (Ill.) 4½ cols.—*Elec. Engr.*, June 1st, 1900.

Electric Workshop.—*A Japanese Workshop.* Very interesting letter describing the works of the Shibaura Engineering Company, situated in Shibaura, a suburb of Tokyo, being by far the largest works manufacturing electrical machinery in Japan, which seems to turn out excellent work, especially of the smaller type, but is said to be unfortunately in an embarrassed financial condition. (Ill.) 1¼ col.—*Lightning*, June 7th, 1900.

Fire-proofing of Wood.—*Rapid Aging and Fire-proofing of Wood by Electricity.* By G. Lengny. The author, referring to the recent destruction by fire of the Theatre Français at Paris, points out that the chemicals used heretofore for impregnating wood to render it incombustible, have proved to be an illusionary protection, and then describes a method invented by MM. Nodon and Bretonneau, by which certain salts are forced into wood pith by means of electricity, and which is used on a commercial scale in certain works at Aubervilliers. (Ill.) 5 cols.—*Revue Technique*, June 10th, 1900.

Motor Meters.—*A Frictionless Motor Meter.* By S. Evershed. Abstract of a paper read before the Institution of Electrical Engineers. The author, after pointing out the unreliability of older forms of meters, as tested by him for several years, describes a meter invented by him, which is practically frictionless and represents great improvements in its construction. (To be continued.) 3¾ cols. (Ill.)—*Elec. Engr.*, June 8th, 1900.

—— *The Evershed Meter.* Description of a frictionless motor meter which is practically a refinement of the well-known Thomson-Houston type, and in which, according to the inventor, the friction moments only vary from 1·7 dyne. cm. in a new, to 3·3 dyne. cm. in one which has run for many million revolutions, as compared with 57 dyne. cm. to as much as 1,400 dyne. cm. in other well-known types. (Ill.) 2½ cols.—*Mech. Engr.*, June 16th, 1900.

Meters.—*The Electrometer in Theory and Practice.* By J. Warren. The author discusses the various types of electro-meters, the theory on which their construction rests, and the requirements of a really useful instrument. (To be continued.) 4 cols.—*Electricity* (London), June 1st, 1900.

—— *The Electrometer in Theory and Practice.* By J. Warren. This is the conclusion of the article on the above subject. 4½ cols.—*Electricity* (London), June 8th, 1900.

Short Circuit Key.—*Rymer-Jones' Short Circuit Key.* Description of a new form of short current key, designed by Mr. J. Rymer-Jones, and to be used not only as a tapper, but to more perfectly short circuit the galvanometer when it is desired to check the instrument zero; and also to obviate any leakage over the *trigger*, cam, or other detent usually employed to retain the key "open" during insulation and earth readings. 1½ cols.—*Elec. Rev.* (London), June 15th, 1900.

Wehnelt Interrupter.—*The Action of the Wehnelt Interrupter on Alternating Currents.* By George T. Hanchett. The author describes the powerful and brilliant secondary effects of the Wehnelt interrupter on an alternating-current circuit of 8,000 alternations per minute. 1¾ col.—*Elec. Wrld. and Engr.*, June 16th, 1900.

MARINE ENGINEERING AND SHIPBUILDING.

1. Merchant Vessels.

Atlantic Liners.—*Across the Atlantic in Four Days.* Note regarding the new steamer which is to be built for the North-German Lloyd Line, which will be the largest vessel afloat, her dimensions being considerably larger than those of the *Oceanic*. ¼ col.—*Steamship*, June, 1900.

2. Pleasure Craft.

Yachts.—*On Yacht Measurement: Together with Some Remarks on the Acting of Sails.* Abstract of a paper read by H. C. Vogt, M. Inst. Danish C. E., at the meeting of the Institution of Naval Architects in London, in which the author draws attention to the enormous sums constantly being spent on the building of sailing yachts, and the advisability, therefore, to frame a yacht-tonnage rule, as simple as possible, but nevertheless resting on scientific principles, the correctness of which should be intelligible to yacht owners, for which purpose, after shortly alluding to the numerous measurement rules in use, he lays down the general principles. 4½ cols.—*Steamship*, June, 1900.

3. Equipment and Machinery.

Engines.—*Launches and their Machinery.* Description of a variety of steam and oil engines suitable for launches, giving their essential dimensions, advantages and disadvantages, and mentioning the names of the builders. 10 cols.—*Marine Engr.*, June, 1900.

Ship Sanitation.—*Disinfectors for Ships' Use.* Description of some forms of the Alliott and Paton's patent improved Lyon's high pressure steam Disinfectors, manufactured by Messrs. Manlove, Alliott and Co., Ltd., Nottingham. 3 cols.—*Steamship*, June, 1900.

4. Docks.

5. Miscellaneous.

MECHANICAL ENGINEERING.

1. Boilers, Furnaces, and Fuel.

Boilers.—*The Working of Water Tube Boilers.* Digest of a recent Board of Trade report, issued in connection with the bursting of a water-tube boiler of the Babcock and Willcox type at the London Electric Supply Company's Station, at Deptford, and containing very full statements on the working of boilers. 2 cols.—*Mech. Engr.*, June 23rd, 1900.

—— *Preparing Boilers for Periods of Idleness.* The author points out that there are machines whose season of usefulness ends with warm weather, and discusses the most important means, for the preservation of such machines during the period of their enforced idleness. 2½ cols.—*Engr.* (Cleveland), June 15th, 1900.

—— *Boiler Testing.*—The author of the article points out that boiler experiments are, as a rule, conducted less easily and with less accuracy than those on a steam-engine, and then proceeds to describe the conditions necessary, and the methods suitable for a boiler test in which the principal results to be obtained are (1) efficiency, (2) pounds of water evaporated per pound of fuel, (3) pounds of fuel burnt per square foot of grate per hour, (4) the calorific value of the fuel. (To be continued.) 5 cols.—*Mech. Engr.*, June 16, 1900.

—— *Boiler Testing.* (Continuation.) This instalment deals with Professor Carpenter's Fuel Calorimeter, a modification of the Thomson instrument, the method of using it, as described in Messrs. Schaffer and Budenberg's instructions, with the calorific value of a fuel calculated from its chemical effects, and with thermal efficiency. 5½ cols.—*Mech. Engr.*, June 23rd, 1900.

—— *Water-Tube Boilers.* Abstract of a lecture on the subject, delivered by Mr. J. T. Milton, M. Inst. C.E., M.I.N.A., at the Poplar Town Hall, under the auspices of the East London Association of Foremen and Marine Engineers, in which the author criticised the defects of water-tube boilers, and suggested improvements. 1½ col. —*Steamship*, June, 1900.

—— *Multi-Tubular Boiler, Borrot Type.* Description of a water-tube boiler of X shape, built by the Boiler-works of Northern France, and distinguished by the ease with which it can be taken to pieces for the thorough cleaning of every part of it, occupying a minimum of horizontal area and permitting the water to circulate freely. The heating surfaces are so arranged that in no place is soot deposited, and the flames have a large and free play. (Ill.) 3¼ cols.—*Revue Technique*, May 25th, 1900.

—— *Boiler Compound Question.* Summary of an answer given by Mr. Edgar, of the Dearborn Drug and Chemical Works to questions proposed by Mr. F. Elmo Stimpson, of Chicago, president of the National Association of Stationary Engineers, relative to the action of soda, ash or caustic soda on steam boilers. 2¾ cols.—*Steamship*, June, 1900.

Exhaust Steam.—*Utilisation of Exhaust Steam for Heating.* By Harry J. Frith, of Watseka, Ill. Abstract of a paper read at the 23rd Convention of the National Electric Light Association, at Chicago. (Ill.) 2½ cols. and 5½ cols. respectively.—*Electricity* (New York), May 30th and June 6th, 1900.

Furnaces.—*Brass Furnaces.* Abstract of an article by Mr. Paul Wever, published in *Foundry*, describing some styles of brass furnaces in use on the Continent, in which the author dates the earliest attempts to improve the brass furnace, from the experiments of Messrs. Piat and Rousseau, of Paris. (Ill.) 2¾ cols.—*Mech. Engr.*, June 23rd, 1900.

—— *Direct Process Furnace.* Description of a furnace devised and patented by Mr. Carl Otto, of Dresden, Germany. The furnace is furnished with a blast of air under pressure which produces an extensively high temperature with the increase of heat gained by the combustion of the gas under high pressure, and an augmented calorific effect is obtained by powerfully reheating the blast and by the combination of any excessive air that may be present, while at the same time the draught can at pleasure be increased, and with it, at the same time the temperature to any desired degree. (Ill.) 1¾ col.—*Am. Mftur.*, May 24th, 1900.

—— *Development Following Decay.* By Christian Larsen. The author illustrates the progress of industry in the region West of the Alleghany Mountains, U.S.A., by describing the oldest furnace built in the district by Isaac Mason, about 1789, which was first blown in March, 1791, and astonished the inhabitants by its capacity of producing what was then considered the "enormous" quantity of 4 tons a day, and the by-product coking plant, in course of erection, of the Semett-Solvay Coke Company at Dunbar, Pa., containing a 300 ton furnace. (Ill.) 1 col.—*Am. Mftur.*, June 14th, 1900.

—— **Reheaters.**—*Reheaters in Multiple Cylinder Engines.* Abstract of a paper by Dr. R. H. Thurston read before the Cincinnati convention of the American Society of Mechanical Engineers, in which the author lays down certain general principles on which the proper construction of the reheater is dependent. 3¾ cols.—*Engrg. Rcd.*, May 26th, 1900.

2. Compressed Air.

Air-Compressors.—*Explosives and Ignitions in Air-Compressors and Receivers.* Abstract of a paper by Alfred J. White in "Proceedings" of the Institution of Civil Engineers, giving an account of a recent occurrence of such an explosion with a description of the compressor and drawing deductions from this with reference to the design of such machinery. 3 cols.—*Engrg. Rcd.*, June 2nd, 1900.

Compressed Air.—*Application of Compressed Air in Railroad Shop Practice.* The author tries to demonstrate on the basis of reliable information gathered from master mechanics, that in case of transmission and application, in adaptability as well as in cost of installation and maintenance, air and electricity are on almost equal footing, but that when we consider the tools by which this power is applied, we find the advantages of the former over the latter. According to him the claim to distinction of compressed air lies in the greater simplicity of the motors required for its local application, to which must be added the important difference in cost. 2¾ cols., June 8th, 1900.

3. Engines and Motors.

Automobiles.—*The 1,000 Miles Trial.* The paper quoted below publishes a complete set of the official average speed tables for the daily runs of the 1,000 Miles Trial, the hill-climbing trials, and the Welbeck mile test, together with the portraits of all the judges and of Mr. Claude Johnson, the Secretary of the Automobile Club of Great Britain and Ireland, 20 cols.—*Automotor Journ.* June, 1900.

—— *The Methods of Automobile Manufacture.* Description of the factories, plant and equipment of the Columbia and Electric Vehicle Company of Hartford, Conn., whose products are sold through the Electrical Vehicle Company, of New York City. (Ill.) 1½ cols.—*Elec. Wrld. and Engr.*, May 26th, 1900.

—— *The Paris Singer Voiturette.* Description of a new type of automobile manufactured by Messrs. Paris Singer, Ltd., at their Clapham works, and built to the designs of Mr. R. M. Campbell, M.I.M.E., the company's engineer and manager. (Ill.) 1½ cols.—*Automotor Journ.*, June 15th, 1900.

—— *Electric Automobiles in Boston.* Description of the plant of the New England Electric Vehicle Transportation Company, inaugurated in May, 1899, and now handles 150 vehicles, thoroughly caring for them, repairing them and supplying them with power. (Ill.) 3½ cols.—*Elec. Wrld. and Engr.*, June 16th, 1900.

—— *Automobiles as a Source of Revenue for Central Stations.* By Elmer A. Sperry. Abstract of a paper read before the National Electric Light Association, Chicago, May 24th, 1900, in which the author points out that, if compressed air is an ideal form of stored power, electric storage distances compressed air in all-important features. (To be continued.) 2¾ cols.—*Elec. Rev.* (New York), June 6th, 1900.

—— *The Automobile Industry.* The article draws attention to the many obstacles that will be in the way of the general introduction of the automobile, and the opposition, both commercial and political, that will be raised once that it is understood, as it must be understood, that the automobile has come to stay. 3½ cols.—*Mech. Engr.*, June 23rd, 1900.

—— *Electric Cab System of Paris.* Description of the electric cabs which, after a severe trial during some months, are rapidly coming into successful operation; in these cabs the rear wheels by means of chain gearing, the wheels being of wood with solid rubber tires. (Ill.) 2½ cols.—*Sci. Am.*, June 2nd, 1900.

—— *Lyle's Steel Wheel.* Description of an interesting type of wheel with hub and spokes made entirely of steel; the hub being made in two parts screwed together with left and right hand threads, while the spokes are made by fitting together loops of rolled steel. The wheel has been well tested on horse-cars and will be tried in the near future on automobiles. (Ill.) ½ col.—*Automotor Journ.*, June, 1900.

Blowing Engines.—*First Blowing Engine fed by Furnace Gases.* Summary of a communication made by Mr. A. Griner, General Director of the Cockerill Society, to the Iron and Steel Institute. 2 cols.—*Génie Civil*, May 19th, 1900.

—— *Blowing Engine Worked by Blast Furnace Gas.* Account of a successful installation made by the engineers of the Société Cockerill, at Seraing, France, and M. Delamare, of Deboitsville, consisting of a 600 h.p. gas engine, worked by unpurified gas taken from the Seraing blast furnaces. (Ill.) 1 col.—*Elec. Rev.* (London), June 1st, 1900.

Fly Wheels.—*Steel Flywheels for the Metropolitan Street Railway Company.* Description of the very interesting features of construction of the fly-wheels with which the great engines of the new power-house of the above-named company are being equipped. These wheels, excepting the hub, are of steel throughout and of the highest order of construction as regards safety; the arms being hollow and most carefully proportioned; the most striking feature—and it appears to be a novelty—is the reinforcement of the plates which are rivetted to the sides of the rim casting. (Ill.) ½ col.—*Am. Mach.*, May 24th, 1900.

Gas Engines.—*Up-to-Date Gasoline Engine.* Description of a gasoline or gas engine outfit of modern type with improved side-shaft valve gear which takes the place of the old two to one spur gear and cam motions and also furnishes the means for driving the gasoline pump, exhaust lever and igniter trip. (Ill.) 1 col.—*Am. Mftur.*, May 24th, 1900.

—— *Testing a 600 horse-power Blast-furnace Gas Engine.* Abstract of the report drawn up, with reference to the Delamare-Debouttéville and Cockerill 600-horse power gas engine, consuming blast furnace gas, by Prof. Hubert, of the Liege Univerity, Belgium. (Ill.) 2¾ cols.—*Coll. Guard.*, June 22nd, 1900.

—— *Gas Engine Economy.* By W. Roberts, M.E. The author points out that the gas engine of to-day, notwithstanding its many excellent qualities, possesses yet a great number of drawbacks generally overlooked, but which are capable of being removed, and suggests a number of important alterations. 2½ cols.—*Mod. Machy.*, June, 1900.

—— *On the Production of and Use of Power that may be developed from Blast-furnace Gas.* Abstract of a paper by Mr. Horace Allen, read before the South Staffordshire Iron and Steel Institute, April 21st, 1900. 2¾ cols.—*Mech. Wrld.*, June 8th, 1900.

Gas Engines.—*The Gas-Engine Hot Tube as an Ignition Timing Device.* Abstract of a paper by Wm. T. Magruder, presented at the Cincinnati meeting, May, 1901, of the American Society of Mechanical Engineers, describing the results of a series of tests made at the Ohio State University at Columbus, Ohio, U.S.A. 5¼ col.—*Mech. Engr.*, June 30th, 1900.

Engines.—*Medium and Low Speed Engines.* The article deals with a number of engines, built in the United States, embodying original and distinctive features; the author dwells on the fact that at the present time there are hardly any special conditions of service that cannot be met by engines constructed to meet these conditions. 24 cols. — *Engr.* (Cleveland), May 15th, 1900.

Triple Expansion Engines.—*The Paris Exhibition II.* The article gives a fairly full description of a great triple-expansion engine constructed by A. Borsig, of Tegel, near Berlin, giving 2,500 b.h.p. and distinguished by great efficiency combined with great simplicity and facility of management. (Ill.) 2 cols.—*Mech. Wrld.*, June 1st, 1900.

Steam Engines.—*The "McInnes-Dobbie" Indicator.* Concise account of two types of an improved steam engine indicator which, after having been tested for 12 months, has been put upon the market by Messrs. T. S. McInnes, of Glasow. (Ill.) 1½ col.—*Mech. Engr.*, June 30th, 1900.

Engines.—*Reheaters in Multiple Cylinder Engines.* Abstract of a paper by Dr. R. H. Thurston, of Sibley College, Cornell University, in which the author gives a short historical review of the use of reheaters, and lays down a number of definite principles, to guide the manufacturer of this kind of apparatus. 4 cols.—*Engr.*, June 1st, 1900.

Pumping Engines.—*Test of a Twenty-Million Gallon Pumping Engine.* Description of a test of a pumping engine which made a very good showing, and was built for the Minnesusa Station of the Omaha Water Company, at Florence, Neb., U.S.A. 1 col.—*Engrg. Rcd.*, June 16, 1900.

—— *Pumping-Engine Test with Superheated Steam.* By E. H. Forster. Abstract of a paper presented at the Cincinnati, Ohio, Meeting of the American Society of Mechanical Engineers, describing a duty test of a small pumping engine, recently installed at the City Waterworks at St. Albans, England. 1¾ col.—*Mech. Engr.*, June 2nd, 1900.

—— *Pumping Engine Test with Superheated Steam.* Abstract of a paper read before the American Society of Mechanical Engineers, referring to the tests made with a small pumping engine constructed by Messrs. James Simpson, and recently installed by them at the city waterworks in St. Albans. The author comes to the conclusion that steam when superheated about 125°F. will do 16 per cent. more work than when saturated; with the feed water passed through an exhaust heater a given amount of fuel will give from 11 to 12 per cent. more work; the engine will give an effective horse power in 18·3 lb. of superheated steam per hour. 1¼ col.—*Mech. Wrld.*, June 1st, 1900.

4. Power and Transmission.

Cranes.—*Giant Crane of 30 Tons.* Description of a gigantic crane exhibited in the machinery hall of the Paris Exposition and devised and built by M. Jules Le Blanc, constructing engineer, from the plans of M. Guyenet. (Ill.) 3½ cols.—*Génie Civil*, May 19th, 1900.

—— *Electric Rolling Bridge and Crane at the Paris Exhibition.* Description of a "rolling bridge" and crane constructed by the firm of Karl Flohr, of Berlin, which has rendered great service in the installation of the machinery in the German section: and can raise 25 tons at the rate of 2·4 metre per minute. (Ill.) ½ col. *Elec. Rev.* (London), May 25th, 1900.

5. Machine Works, Shop and Foundry.

Boiler Shops.—*The Arrangement of Boiler Shops.* By F. M. Whyte, M.E., of the New York Central and Hudson River Railroad. The author discusses the objects to be kept in view in the construction of boiler shops, and dwells on the importance of adapting the features of the shop to the character of the work which predominates in the shop. 3 cols.—*Am. Engr. & Rd. Journ.*, June, 1900.

Foundry Work.—*Some Notes on Pipe Founding.* By E. Kebler. Abstract of a paper read before the Foundrymen's Association. The author, after pointing out that a cast flange pipe is said to have been used on a pump erected under the arches of London Bridge as early as 1582, passes over the older methods and describes the most efficient modern practice. (Ill.) 1¼ col.—*Iron and Coal Trds. Rev.*, May 25th, 1900.

Lighting.—*Artificial Light with Special Reference to Engineers' Shops.* By A. E. Edwards. Abstract of a paper read before the Birmingham Association of Mechanical Engineers, May, 1900, in which the author discusses the respective advantages of various kinds of artificial light. 5½ cols.—*Gas Wrld.*, June 2nd, 1900.

Steam Ram.—*The Erwin Steam Ram.* Description of a water-raising device introduced by the Penberthy Injector Company of Detroit, Mich., U.S.A., called a "steam ram." By this mechanism 4,000 to 8,000 gals. per hour can be raised to heights as great as 60 ft., depending on the size of the ram and lift; the steam pressure used is about 75 lb. (Ill.) ¾ col.—*Mech. Wrld.*, June 8th, 1900.

6. Tools.

Boring and Turning Machines.—*Combined Turret Head Boring and Turning Machine.* Concise account of a machine constructed by Messrs. Geo. Richards and Co., Broadheath, near Manchester, which is of a new design and is capable of turning and boring pieces up to 31 in. diameter and 12 in. deep. (Ill.) ½ col.—*Mech. Engr.*, June 9th, 1900.

—— *Boring and Turning Mill.* Description of the largest boring and turning mill ever built in the United States, and probably in the world; being constructed by the Niles Tool Works at Hamilton, Ohio, for the Edward P. Allis Company's shops. Its weight is 250,000 pounds and it is equally well adapted to boring large cylinders and turning fly wheels up to 24 ft. in diameter. The power on the table exerts a pull of 22,000 lbs. on tools cutting sixteen feet in diameter and 14,000 lbs. on tools 24 ft. in diameter. (Ill.) 1 col. *Mod. Machy.*, June, 1900.

Drilling Machines.—*Some Improved Drilling Machines.* The article deals with several designs of radial drilling machines, constructed by George Swift, of Claremont Ironworks, Halifax, distinguished by various improvements. (Ill.) 1 col. *Mech. Engr.*

Machine Tools.—Description of a number of British made machine tools of superior workmanship, manufactured by Messrs. Alfred Herbert, Ltd., at their works in Coventry; this company having for some time made a feature of capstan and automatic lathes, milling machines, drilling machines, cutter grinders, etc. (Ill.) 3½ cols.—*Automoler Journ.*, June, 1900.

Screw Threads.—*New Departure in Thread Cutting.* Description of the Rivett-Dock Tool, which makes an absolute correct thread in the cuts, and is an invention of Herman Dock, of Philadelphia, and patented by him in the United States and Europe; it appears to be undoubtedly a remarkable improvement in lathe-threading. (Ill.) 1¾ col.—*Am. Mfctr.*, June 7th, 1900.

Tools and Machinery.—*The Paris Exhibition IV.* This is an editorial correspondence dealing in a very lucid and interesting manner with some of the exhibits at the Paris Exposition, among them Worthington pumps, American wood-working machinery, some Flather lathes, and, above all, the Iron and Steel Exhibit of Sweden. (Ill.) 10 cols.—*Am. Mech.*, June 7th, 1900.

Turret or Revolving Head.—*Origin of the Turret or Revolving Head.* By E. G. Parkhurst. The author, correcting a statement with reference to the subject in the *Engineering Magazine*, discusses the question of who was the inventor of the revolving turret-head for screw machines, and tries to show that the honour is due to one Stephen Fitch, who constructed a self-revolving turret-head screw machine in 1845. (Ill.) 6 cols.—*Am. Mech.*, May 24th, 1900.

7. Refrigeration and Cold Storage.

8. Miscellaneous.

Gear Teeth.—*The Strength of Gear Teeth.* By Robert A. Bruce. The author deals with the matter on the basis

of a paper entitled "Investigation of the Strength of Gear Teeth," read before the Engineers' Club of Philadelphia on Oct. 15th, 1892, by Mr. Wilfred Lewis, who in conclusion gives an equation for determining the strength of bevel wheels, and convenient approximization, sufficiently accurate for most purposes; to this Mr. Bruce adds an alternative equation, or rather gives the same equation expressed in different terms. 5 cols.—*Am. Mach.*, May 31st, 1900.

Liquid Air.—*Applications of Liquid Air.* Abstract of a paper jointly produced by Prof. Raoul Pictet, formerly of Geneva, and Moriz Burger, of New York, dealing chiefly with the separation of the constituent gases of liquid air, and describing the air liquifying process adopted by the Air Liquifying and Refining Company. Both authors expressed in very strong terms their scepticism as regards the practical value of liquid air as a direct source of power or as a refrigerating agent, illustrating their views by putting into operation a small liquid air engine which developed about half horse-power for a period of five minutes; to accomplish this four gallons of liquid air were used, including that lost by evaporation, and each of these required about four horse-power for its production, which clearly showed the absurdity of deriving power from this source. 2 cols. *Am. Mftrr.*, June 1st, 1900.

—— *The Practical Applications of Liquid Air.* By Carl Linde. Abstract of a paper read by the author before the Society of German Naturalists and Physicians at Munich. 5½ cols.—*Mech. Engr.*, June 16th, 1900.

Printing Machines.—*A Mammoth Engineering Firm.* Very full description of the works of Messrs. R. Hoe and Co., of New York and London, in the United States and in England, and of the various types of printing machines manufactured there. (Ill.) 24 cols. —*Brit. and Col. Printer and Stationer*, June 21st, 1900.

Water-Softening.—*Water-Softening Plant at the Lorain Steel Company's Blast Furnaces.* Abstract of a paper by Mr. N. O. Goldsmith, read at the 41st meeting of the American Society of Mechanical Engineers, in which the author describes the process and plant for purifying water containing 16,548 grains of mineral matter, etc., per gallon, which forms a scale in boilers that can be removed only with difficulty. The process described is based upon the knowledge of the exact quantity and character of the impurities contained in the water. 3¾ cols.—*Engr.* (Cleveland), June 1st, 1900.

MINING AND METALLURGY.

1. Coal and Coke.

Coal Mining.—*Lignite Mines of Gardanne (Bouches-du-Rhone).* The article deals with a pamphlet published recently by M. Domage, Director of the New Colliery Society of the Department Bouches-du-Rhone, in which he describes the building of a large gallery in course of construction, leading from the lignite mines of Gardanne, near Marseilles, to the ocean, and gives an account of the methods adopted and the machinery employed for accomplishing this interesting engineering feat, which is progressing very satisfactorily. (To be continued.) 5 cols.—*Génie Civil*, May 26th, 1900.

—— *Lignite Mines of Gardanne (Bouches-du-Rhone).* Conclusion of the article begun in the issue of May 26th, 1900. 4 cols.—*Génie Civil*, June 9th, 1900.

—— *Surface Arrangements of a Belgian Colliery.* Abstract of an administration report by M. C. Minsier, Ingénieur-en-Chef, Directeur des Mines, at Charlerol, and of the statistical list of Belgian Collieries, worked during 1899, in the *Annales des Mines de Belgique.* (Ill.) 3¼ cols.—*Coll. Guard.*, June 22nd, 1900.

—— *Co-operative Coal Mining in Queensland.* By Harrison F. Bulman. Description of the Aberdare Colliery, situated at Blackstone, a little place not far from Ipswich, being one of the largest and most important collieries in Queensland, and having a special interest, because since 1894 it has been conducted on co-operative principles, the control being in the hands of the workmen; its yearly output is about 80,000 tons. (Ill.) 2½ cols.—*Coll. Guard.*, June 15th, 1900.

Coal Mining.—*Sinking through Quicksand at an Austrian Colliery.* By K. Hoftich. Abstract of an article published in the *Oesterreichische Zeitschrift für Berg-und Hüttenwesen*, in which the author describes the sinking of a shaft at Sollenau, in Lower Austria, to tap a seam of lignite at a depth of 205 m. (672 ft.), which offered various difficulties, more particularly in traversing a bed of quicksand, 22 ft. in thickness, at a distance of 510 ft. below the surface. (Ill.) 1¾ col.—*Coll. Guard.*, June 22nd, 1900.

—— *Coal Mining in Queensland.* By Harrison F. Breman. The author demonstrates that, although coal mining in Queensland is somewhat handicapped by the nearness of New South Wales, with its existing possession of such limited trade as there is, and producing 70 per cent. of the entire output of Australasia, and New Zealand coming next with 15 per cent., there is no doubt Queensland possesses extensive deposits of various qualities. 2½ cols.—*Coll. Guard.*, June 8th, 1900.

—— *The Coalfields of Ireland.* The author of the article gives a brief outline of the general character of the Irish coalfields and of the conditions under which they occur, so that an opinion may be gained as to how far they are in themselves adapted for development. (Ill.) 5 cols.—*Coll. Guard.*, June 15th, 1900.

—— *The Coal Deposits of Natal.* Digest of a series of articles on the Natal coal industry, by Mr. William Taylor, published in *Industries* (Durban), in which the author describes the character and quality of the coal deposits of the colony, which are represented by two workable sections. (Ill.) 2 cols.—*Coll. Guard.*, June 22nd, 1900.

—— *The Great Coke Region of America.* By Wm. Gilbert Irwin. The article is devoted to a description of the industries of Connelsville, the famous coking region of Western Pennsylvania, which produces coke unexcelled in excellency for foundry and furnace purposes, though the methods used are somewhat behind time. 1¼ col. *Coll. Guard.*, June 8th, 1900.

—— *Running Collieries Entirely by Electricity from One Centre.* By Sidney F. Walker. Extract of a paper read before the British Association of Mining Students, in which the author illustrates the great economy possible by centralising the power supply and using electric transmission. 2¾ cols.—*Iron and Coal Trds. Rev.*, May 25th, 1900.

—— *The Coalfields around Tsé Chow, Shansi, China.* By Noah Fields Drake. Abstract of a paper read before the American institute of Mining Engineers, containing interesting information gathered by the author during a sojourn in that part of China in midsummer, 1899. (Ill.) 3 cols.—*Iron and Coal Trds. Rev.*, May 25th, 1900.

—— *Working Deep Coal Beds.* By H. M. Chance. The author describes a new method of overcoming some of the difficulties met with as mines attain a greater depth and serving to enlarge the area that can be mined from a given shaft, to increase the output, to reduce the timbering required on haulage roads, to remove the danger of closure of haulage roads and air-ways by squeezing, to provide adequate ventilation for emergencies, such as outbursts of gas, to provide increased transportation facilities, and to do all this without expense in excess of that of systems in common use. 3 cols.—*Mines and Minerals*, May, 1900.

—— *Draining Gas from Gob Workings.* Abstract of a paper by Chas. Connor, Mine Inspector, Uniontown, Fayette Co., Pa., in which the author describes a very successful experiment of draining off the dangerous gases in a certain portion of the mine in which explosive gas has never since been discovered. 1¾ cols.—*Mines and Minerals*, June, 1900.

Coal Trade.—*The Export Trade in Coal.* Discussion of the coal production of the world, with special reference to the American commerce in this important article of fuel, and containing indications of future openings in the world's market. 4 cols.—*Am. Mftrr.*, June 1st 1900.

2. Copper.

Copper Mining.—*The Nacosari Mines, Mexico.* Description of the development of the Great Pilares copper mine, Nacosari, in Sonora, Mexico, and the construction of the big concentrating, smelting, and converting plants erected there by the owners, *i.e.*, the Montezuma Copper Company. (Ill.) 2 cols. (To be continued.)—*Engrg. and Min. Journ.*, June 9th, 1900.

Copper Mining.—*Lake Superior Mining Region.* Abstract of an address by President William Kelly at the February meeting of the Lake Superior Mining Institute, in which he compares the present condition of the mining industry in that region with that of former years, and dwells on the great changes effected by the introduction of new machinery and new methods. 4¾ cols.—*Mines and Minerals*, June, 1900.

—— *The Rio Tinto Mines.* By Thomas E. McKenzie. Description of the above-named famous copper mines in Spain, translated from the Spanish. 8 cols.—*Austr. Min. Stand.*, May 24th, 1900.

—— *Copper Statistics.* Digest of the February circular of Messrs. Aron Hirsch and Sons, of Adelaide, edited by Mr. Francis H. Snow, containing an exhaustive review of the position respecting copper supply, demand and exchange. 2¼ cols.—*Aust. Min. Stand.*, May 10th, 1900.

3. Gold, Silver and Gems.

Diamonds.—*Black Diamonds.* The article describes the mining of black diamonds, which are found only in the regions of the Cape of Good Hope and the provinces of Bahia, Brazil, and are divided into two classes, named respectively "carbons" and "corta." 1 col.—*Sci. Am.*, June 16th, 1900.

Gold Mining.—*Gold Mines in Glaciated Regions.* By Prof. George H. Stone. The author points out the causes of the different conditions from those prevailing in districts not affected by glaciation, and advises intending miners to familiarise themselves with the nature of glacial deposits before beginning to work there. 3½ cols.—*Mines and Minerals*, June, 1900.

—— *Cape Nome.* This is a digest of an article by T. C. Schrœder, published in the *National Geographical Magazine*, supplemented by consular reports and correspondence to various newspapers, describing the metalliferous deposits, climatical conditions and social life of the new Alaskan Ophir. 2½ cols. and 3 cols. respectively. —*Aust. Min. Stand.*, April 26th and May 3rd, 1900.

—— *The Auriferous Sands of Cape Nome (Alaska).* Article dealing with the general conditions of the new Eldorado at the south-end of the Seward Peninsula in Norton Bay, Alaska. 4½ cols.—*Génie Civil*, June 9th, 1900.

—— *Gold-Dredging Machinery.* Description of gold-dredging plants of the New Zealand type, which will be in great demand in British Columbia during the present year, and is being introduced by the Discoverer's Financial Corporation and the Universal Corporation of London. 2½ cols.—*Mod. Machy.*, June, 1900.

—— *Dredging for Gold.* By J. W. H. Piper, M.I.M.E. Abstract of a paper read before the Chamber of Mines of New South Wales, in which the author discusses a subject which, as he says, is likely to prove one of the most important branches of the mining industries of that colony, namely, "bucket dredging," and adds a few remarks on hydraulic elevating and sluicing. 2½ cols. *Aust. Min. Stand.*, May 10th, 1900.

—— *The Lone Fine Surprise Consolidated Mines, Republic, Washington, U.S.A.* By M. H. Joseph. Account of one of the most prominent groups of mining claims owned by the above mining company, of Spokane, Washington, including the Lone Pine, Pearl, Surprise, and Last Chance claims, situated on the east side of Eureka Creek. (Ill.) 3½ cols.—*Engrg. and Min. Journ.*

—— *The Golden Mountain—A Retrospect.* By Wm. Bradford. A historical review of the discovery and the working of a very interesting and important Australian mining region. (Ill.) 2½ cols., 2½ cols. and 2⅝ cols. respectively—*Aust. Min. Stand.*, April 26th, May 3rd and May 10th, 1900.

—— *Tarcoola Goldfield.* De cription of the Tarcoola goldfield recently discovered in South Australia, situated about 15 miles in a north-westerly direction from Wilgena Head Station and 295 miles from Port Augusta. (Ill.) 1½ col.—*Austr. Min. Stand.*, April 26th, 1900.

—— *The Cyanide Process of Gold Extraction.* Review of a volume by James Park on the subject published recently in London after three previous editions published in New Zealand, and containing a very useful and admirably arranged description of the theory and practical working of this method. 1½ col.—*Nature*, June 14th, 1900.

4. Iron and Steel.

Pig Iron.—*The Past and Future of Pig Iron.* By James A. Green, of Cincinnati. Abstract of a paper read before the National Association of Stove Manufacturers, New York, May 9th, in which the author, after pointing out that the United States produce the greatest amount of pig-iron in the world, declares, that in order to profit by this great advantage, Americans should turn out the most perfect manufactures of pig-iron. 2 cols.—*Iron and Steel Trds. Journ.*, June 2nd, 1900.

Iron and Steel Metallurgy.—*The Metallurgy of Iron and Steel.* By Prof. A. H. Sexton. The author in the present portion of his contribution, discusses the character of the various varieties of iron, known under the name of steel, and their division into: Puddled Steel, Cement Steel, Crucible Cast Steel, Bessemer Steel, Siemen's Steel and Basic Steel, adding an analysis of the chemical composition of steel. (To be continued.) 6 cols.—*Mech Engr.*, June 23rd, 1900.

—— *Riddles Wrought in Iron and Steel.* Abstract of a paper by Paul Kreuzpointner, read before the Metallurgical Section of the Franklin Institute. The author draws attention to the great number of anomalous changes occurring in the melting of iron and steel and inquires into their probable causes. (To be continued.) 2 cols.—*Mech. Wrld.*, June 22nd, 1900.

Iron and Steel Trades.—*What is the Competitive Outlook in the World's Iron and Steel Trades?* By H. J. Skelton, London. The author points out that according to the law of periodicity, the prosperous period of the trade that has already lasted nearly five years, *i.e.*, longer than ever since the exceptional period of 1873, must sooner or later be approaching its end, and that it is a wise, though uncongenial thing, to look forward to a less prosperous condition of things, and then proceeds to discuss the way in which the decline of prosperity can best be met and rendered least harmful to the welfare of British industries. 6 cols.—*Iron and Steel Trds. Rev.*, June 16th, 1900.

Iron Trade.—*Statistics of the Canadian Iron Trade.* Digest of the Annual Statistical Report on the iron and steel industry in the United States, Canada and Mexico, by Mr. James M. Swank, summarising the data referring to the Dominion of Canada. 3 cols.—*Canadian Mfturr.*, June 1st, 1900.

Iron Mining.—*The Iron Ore Mines of Elba.* Digest of the report on the trade and commerce of Elba for the year 1899, by the Vice-Consul Tonietti with comments by the author. 1½ col.—*Iron and Steel Trds. Journ.*, June 23rd, 1900.

—— *The Iron Ore Resources of Canada.* By Walter R. Nursey. The present instalment of this contribution deals with the iron deposits in Newfoundland, notably the vast hæmatite deposits on Bell Island, and the deposits of Nova Scotia which is also rich in collieries. (Ill.) 2 cols.—*Iron and Coal Trds. Rev.*, June 8th, 1900.

—— *The Iron Ore Resources of Canada.* By W. R. Nursey. (Conclusion.) The concluding portion of this contribution is devoted to iron mining in Ontario, which has practically inexhaustive iron ore deposits which have been so far overlooked on account of the other mineral resources of the province. 5 cols.—*Iron and Coal Trds. Rev.*, June 15th, 1900.

5. Mining and Mining Methods.

Hoisting Engines.—*Hoisting Equipment for Mines.* Short description of one of three hoisting engines lately built by the Edward P. Allis Company of Milwaukee for the Quincy Mining Company, U.S.A. The machines are said to be very effective and well built. (Ill.)—*Mod. Machy.*, June, 1900.

Mining.—*On the Theory of Timbering.* By Henry Louis, M.A., Professor of Mining, Durham College of Science, Newcastle-on-Tyne. The author expresses his satisfaction at the beneficial effect of the Home Office Circular on the subject, in so far as it has drawn general attention to the importance of timbering, reviews briefly the little that is known regarding the principles underlying a rational system of timbering, and then enters upon an analysis of the mechanics of the question. 3¾ cols.—*Mines and Minerals.*

Mining.—*Underground Workings at the Paris Exposition.* Description of a group of side-shows illustrating underground mining, such as the reproduction of an iron pyrites mine, like that of Saint Bel, near Saint Etienne, of a Colorado gold mine, a Transvaal gold mine, &c. 1¼ col.—*Engr. and Min. Journ.*, June 16th, 1900.

Rock Drills.—*The Gas Rock Drill.* Abstract of a report by Mr. Consul Powell on the trade and commerce of Philadelphia, U.S.A., in which he describes a rock drill worked by a gas engine, closely resembling the ordinary form of steam or air drill, the radical difference being only in the motive force. 1¼ col.—*Coll. Guard.*, June 8th, 1900.

6. Miscellaneous.

Manganese Ores.—*The Manganese Ores of Brazil.* By Herbert Kilburn Scott. Abstract of a paper read before the Iron and Steel Institute, May, 1900. The author after a short account of mining and metallurgical industry in the State of Minas Geraes, treats more fully of the manganese deposits and mining in that region. (To be continued.) 4¾ cols.—*Iron and Steel Trds. Journ.*, June 9th, 1900.

Metal Castings.—*Yellow metal Castings.* By Longmuir. The article describes the most suitable methods for yellow metal castings and the necessary precautions to be taken in order to obtain first class work. It is a reprint of a contribution to *Foundry.* 1½ col.—*Mech. Wrld.*, June 22nd, 1900.

Mining.—*The Bear Butte Mineral Formation.* By Robert W. Barrel, E.M. The author describes a very interesting mining region situated about 8 miles southeast of Deadwood, South Dakota, belonging to the famous Black Hills, an isolated mountain group having an extent of about 100 miles north and south and 60 miles east and west, representing an uplift independent from the Rocky Mountains. (Ill.) 3¼ cols.—*Mines and Minerals*, June, 1900.

Mining and Metallurgy.—*The United States Mining Exhibit at the Paris Exhibition.* By O. C. Farrington. Concise description of the exhibit of the United States in the department of mining and metallurgy which is very creditable, and contains a large and thoroughly representative collection of ores and minerals of the country together with metallurgical and manufactured products. (Ill.) 1¼ col.—*Engrg. and Min. Journ.*, May 26th, 1900.

Nickel Ores.—*The Canadian Nickel Agitation.* The article deals with the consequences which the export duty proposed by some Canadians on exports of nickel from the Dominion would have for the nickel mines near Sudbury, Ontario, and comes to the conclusion that the nickel matte, the product which is obtained by smelting the nickel ores, cannot profitably be refined in Ontario; the result, therefore, of the export duty would be the closing of the Sudbury mines and the end of an important industry. The article gives a clear exposition of the subject from this point of view and is very interesting reading. 3½ cols.—*Am. Mftrr.*, May 27th, 1900.

Salt Mines.—*Salt Mines of Avery's Island, Louisiana.* By Major Henry Remeyn, U.S.A. The author describes the works and the interesting geological formation of the district, which furnishes frequently gigantic blocks of the saline material, some of them weighing many tons each. (Ill.) 3 cols.—*Mines and Minerals*, May, 1900.

Salt Production.—*The Manufacture of Salt.* The article deals with the large salt deposits in Manistu, Michigan, U.S.A., and describes the thoroughly representative and modern plant of the Buckley and Douglas Lumber Company of that town. (Ill.) 3 cols.—*Sci. Am.*, June 9th, 1900.

Zinc Coating.—*Zinc a protective Coating for Iron and Steel.* Abstract of a paper by Mr. Sherard Cowper-Coles, A.M., Inst.C.E., M.I.M.E. The author states that zinc as a protective coating for iron, after a trial of 50 years, has proved itself more effective than painting. Iron coated with zinc by passing it through a molten bath of that metal has the somewhat misleading name of "galvanized iron"; the name, however, does not refer to the process, but to the nature of the protective influence of the zinc. Mr. Sherard Cowper-Coles describes various processes for zincing iron and concludes with a description of a plant for electro-zincing wire, tubes, plate, &c. 2½ cols.—*Mech. Wrld.*, June 8th, 1900.

Zinc Mining.—*Sinking Parker Shaft.* By J. A. Van Mater. The article gives a description of sinking the Parker shaft, at Franklin Furnace, Sussex County, N.J., with a view of reaching the lower edge of the great zinc deposit of that place, dwelling on the placing of the holes for blasting, the method of firing by a dynamo, the plans of timbering and the means used to control the inflow of water in the shaft. (Ill.) 6 cols.—*Mines and Minerals*, June, 1900.

Zinc Smelting.—*Smelting Process for Zinc Ores.* Description of a method devised by Dr. Emil E. Lungwitz, a mining engineer of great experience, and based upon a sound scientific foundation, established by careful experiments made in the laboratory of the Royal Polytechnic School of Berlin by himself and Dr. R. C. Schüpphaus. 1¼ col.—*Sci. Am.*, June 9th, 1900.

Lead and Zinc Industry.—*The Missouri Lead and Zinc Company Plant.* Description of the plant of one of the most important mining companies doing business in the Missouri-Kansas zinc and lead mining districts, carrying on operations on a scale of greater magnitude than probably any other company in the district. 1 col.—*Engrg. and Min. Journ.*, June 2nd, 1900.

MUNICIPAL ENGINEERING.

1. Gas Supply.

Gas Lighting.—*The Incandescent Gas Mantle and its Use.* By Vivian B. Lewis, F.I.C., F.C.S. This is the last of a course of three Cantor lectures delivered at the Society of Arts, delivered May 14th, 1900, by the author, who is Chief Superintending Gas Examiner to the Corporation of London, 7 cols.—*Journ. of Gas Lghtng.*, May 29th, 1900.

Gas Works.—*Saving and Concentration of Ammonia.* Extracts from a paper read before the Michigan Gas Association, by Mr. George Orins, of Detroit, in which the author suggests to the owners of small gas works, carbonizing from 1000 tons of coal per annum, the advisability of utilising their ammonical liquor. 1¾ col.—*Gas Wrld.*, June 23rd, 1900.

—— *Gas Making at Singapore.* A chat with Mr. A. Ford. This is a very interesting interview with a British engineer, who has spent a considerable time in Singapore, in connection with the gas works there, of which he was to undertake the management. (Ill.) 2¾ cols.—*Gas Wrld.*, June 2nd, 1900.

—— *Improvement in Gas Manufacture.* Description of a process patented by John Coyne, of Pittsburg, Pa, U.S.A., by which, according to the inventor, 50,000 cubic feet of gas is derived from one ton of coal, while the usual processes average from 9,500 to 10,000 feet. (Ill.) 2 cols.—*Am. Mftrr.*, June 14th, 1900.

—— *The New Gas.* Under this title Mr. W. H. Y. Webber delivered a lecture before the Gas Institute on June 12th, in which he described the prospects for coal gas manufactured by new methods for heating purposes and pointed out that Sir William Siemens, twenty years ago, had recommended a system of duplex coal carbonization, in which two-thirds of the make should be reserved for sale as illuminating gas and the remaining one-third be diverted for sale separately as heating gas. 8½ cols.—*Journ. of Gas Lghtng.*, June 19th, 1900.

—— *Determination of Benzine and Ethylene in Coal Gas.* By Professor F. Haber, Ph.D. Abstract of a translation of the author's contribution to the *Journal für Gasbeleuchtung* on the above subject. 2¾ cols.—*Journ. of Gas Lghtng.*, May 29th, 1900.

—— *The Guide-Framing of Gasholders.* By Mr. Hacker of Berlin. Abstract of a translation of an article by the author, first published in the "Journal of the Association of German Engineers" and reproduced in the Austrian paper, *Der Gastechniker.* (Ill.) 3½ cols.—*Journ. of Gas Lghtng.*, June 5th, 1900.

2. Sewerage.

Sewage.—*The Oxidation Process for Sewage Treatment.* By Prof. Dünbar, of Hamburg. Short abstract of a series of long articles by the author in the *Journal für Gasbeleuchtung*, in which the author demonstrates that no single process is applicable to all cases and the process has to be varied according to circumstances. ½ col.—*Journ. of Gas Lghtng.*, June 5th, 1900.

Sewage.—*The Septic Tank System at Independence.* The article deals with the sewage disposal method in use at Independence, Mo., U.S.A., a town having an area of 3½ square miles. 1½ col.—*Engng. Rcd.*, June 16th, 1900.

—— *Bacteriological Purification of Sewage.* By W. H. Harrison, B.Sc. Abstract of an address on the subject by the author, delivered at a session of the Yorkshire Section of the Society of Chemical Industry, held at the Yorkshire College, Leeds, and a summary of the discussion. ½ col.—*Public Health Engr.*, June 2nd, 1900.

—— *The Bacterial Treatment of Sewage.* By Frank Clowes. The author gives a very lucid summary of this treatment and the scientific data underlying it, as well as of the process in its practical aspects and dwells on the fact that the warmest advocates of it are those that have had the longest experience of its working. (Ill.) 6 cols. —*Nature*, June 7th, 1900.

—— *City of Paris Sewage Disposal.* By Ralph E. Gett. Abstract of a translation of an article on the subject published in *La Revue Technique*. Description of the vast enterprise inaugurated on July 8th, 1899, from which date city sewage has ceased to flow into the river Seine. (To be continued.) 4½ cols.—*Public Health Engr.*, June 16th, 1900.

—— *City of Paris Sewage Disposal.* Translation from *La Revue Technique*, abridged, which is concluded with the present instalment, dealing with the purification of sewage, the Plain of Gennevilliers, Acheres Agricultural Park, and the produce of the Gennevilliers farm. 1½ col. —*Public Health Engr.*, June 23rd, 1900.

3. Streets and Pavements.

4. Water Supply.

Water-Works.—*Water-Storage Systems at Fort Terry and Lacona, New York.* Description of water-works with storage tanks into which the water is pumped, and from which it is supplied to the distributing mains under constant pressure maintained by auxiliary air-tanks. This system adopted at the places above-named and some other American towns, is operated under patents issued to Mr. Oscar Darling and the late Wm. E. Worthen, and has been installed by the Acme Water Storage and Construction Company, New York, of which Mr. Marling is Secretary. Its characteristics are, that it dispenses with stand pipes, elevated tanks, and direct pump pressure, provides for instantaneous increase of pressure for emergencies, and permits the subterranean storage of ground water. 1½ col.—*Engrg. Rcd.*, May 26th, 1900.

—— *The Water Supply of Liverpool.* Digest of a report just published by the water-engineer to the Corporation of Liverpool, Mr. J. Parry, M. Inst. C.E., the first portion of which is historical, and the second portion of which deals with the present state of the works. 1½ col. —*Journ. of Gas Lghtng.*, June 19th, 1900.

—— *Purleigh District Water-Supply Works.* Description of water-works erected in the rural district of Malden, the construction of which began in March, 1899, the constructional works being entrusted to Mr. E. West, of Chelmsford, who undertook the erection of the pumping station and of a collecting reservoir; the springs for the water supply are situated in the parish of Woodham Walter. 4½ cols.—*Contract. Journ.*, June 20th, 1900.

—— *Water Purification at Norfolk, Vermont.* Abstract of a paper by Mr. Edmond B. Weston, M. Am. Soc. C.E., of Providence, R.I., containing many points of interest in a filter-plant at Norfolk, Virginia, U.S.A., prefaced by a review of the conditions preceding its establishment, and followed by detailed statements regarding its operation. (Ill.) 6 cols.—*Engrg. News*, May 24th, 1900.

—— *The Water-works of Crisfield, Md., U.S.A.* Description of a small water-works plant, possessing a number of points of interest, recently completed in a small town of Maryland, from plans by Mr. E. M. Kenly, of Baltimore. 1½ col.—*Engrg. Rcd.*, June 2nd, 1900.

—— *Repairing a Submerged Water Main.* By Mr. D. W. French. Abstract of a paper read before the American Water-works Association, in which the author describes the repairing of a 30-in. main, being one of the three force mains which connect the principal pumping station of the Hackensack Water Company with their reservoirs at Wechawken, N.J., U.S.A. 1½ cols.—*Journ. of Gas Lghtng.*, June 10th, 1900.

5. Miscellaneous.

NAVAL AND MILITARY ENGINEERING.

1. War Vessels.

Battleships.—*United States Battleship "Georgia," and Class.* Article giving the essential data of the U.S. battleship *Georgia*, and her class-mates, provided for under the Act of March 3rd a year ago, and these data are taken from the circular recently issued. (Ill.) 1½ col.—*Sci. Am.*, June 9th, 1900.

Cruisers.—*Protected Cruisers of the "Denver" class for the U.S.N.* Description of an interesting type of cruisers, showing a number of important departures from recent practice in their construction, such as modification of speed, the provision of a liberal coal bunker for 700 tons, when fully stowed, wood sheathing and coppering the steel outside plating to slightly above water line, &c. (Ill.) 5 cols.—*Marine Engrg.*, June, 1900.

Destroyers.—*Further Trials of the Turbine-Driven Torpedo-Boat Destroyer "Viper."* Short account of a series of trials made over the measured mile during the month of May, in which an average speed of 34·25 knots was maintained, though the trial conditions were not favourable. 2 cols.—*Marine Engrg.*, June, 1900.

Ironclads.—*German Ironclads.* Description of the *Kaiser Wilhelm*, one of the five great vessels of the type of *Kaiser Friedrich III*, the chief dimensions of which are: total length, 115 m.; width, 20·40 m.; medium draught, 7·30 m.; displacement, with a load of 650 tons of coal, 11,000 tons. (Ill.) 3½ cols.—*Le Yacht*, June 16th, 1900.

Submarine Navigation.—*Motive Force and Propelling.* (Conclusion.) In this article M. H. Noalhat concludes his detailed article on Submarine Boats, dwelling mainly on the data referring to the use of electricity in propelling this peculiar craft. 7½ cols.—*Revue Technique*, May 25th, 1900.

2. Equipment.

3. Armour Plates, Guns and Ammunition.

Guns and Armour Plate.—*Manufacture of Guns and Armour at the Bethlehem Steel Works.* This is the second instalment on the subject, and deals with fluid compression and forging. (Ill.) 2½ cols.—*Sci. Am.*

4. Manufacture of Arms.

5. Miscellaneous.

Cable Cutting.—*Cable-cutting Operations of U.S.S. "St. Louis" during the Spanish War.* By Captain Caspar F. Goodrich, U.S.N. Very interesting article describing the operation of cutting every foreign cable leading to Cuba, carried out by the American liner *St. Louis*, when used as an American auxiliary cruiser under command of the author. (Ill.) 6½ cols.—*Marine Engrg.*, June, 1900.

Weapons.—*A Curious Historic Weapon.* By Robert Wilson, D.D. Description of a "flint-lock" double-barrelled revolver, originally belonging to one Thomas Smith, Esq., who later was created "Hereditary Landgrave of Carolina," and owned an immense estate in that colony. The weapon is owned by a descendant. 1½ col. —*Sci. Am.*, June 16th, 1900.

RAILWAY WORK.

1. Motive Power and Equipment.

Fire Boxes.—*The Wide Fire-box as a Standard.* By J. Snowden Bell. The author points out that the inventor of the wide fire-box, which dates from 1854, died too early to reap the benefit of its popularity, but that at present the narrow fire-box has outlived its usefulness, and the wide fire-box should be standard in all classes of locomotives. 3½ cols.—*Am. Engr. and Rrd. Journ.*, June, 1900.

—— *Central Water Leg applied to Wootten Fire-boxes.* By W. McIntosh, Suptdt. of Motive Power, Central R.R. of New Jersey. The author describes a centre water leg designed by him to improve the rather sluggish water circulation in boilers of the Wootten type. (Ill.) 1½ col. —*Am. Engr. and Rrd. Journ.*, June, 1900.

Locomotives.—*New type of American Freight Locomotive.* Description of a type of freight locomotives, of which four have recently been built by the Chicago, Burlington and Quincy Railroad, to the design of Mr. F. A. Delano and Mr. F. H. Clark, which will be known as class "R" or "Prairie" type, and contain several innovations. 3 cols.—*Mech. Engr.*, June 30th, 1900.

—— *Types of American Narrow-Gauge Locomotives.* The author points out the great difference in idea presented by American engines in comparison with our own, and then proceeds to describe several types of American light-railway engines. (To be continued.) 2½ cols. (Ill.) —*Mech. Engr.*, June 16th, 1900.

—— *Types of American Narrow-Gauge Locomotives.* (Conclusion.) This final instalment deals with tank engines of the "double tender" type, with either four or six wheels coupled. (Ill.) 1¾ col.—*Mech. Engr.*, June 23rd, 1900.

—— *Atlantic Type Fast Passenger Locomotives.* Description of a locomotive of the Pennsylvania Railroad class E. 1, of a type of which three were built last year at the Juniata shops, Altona, and built into the Atlantic service last summer. (Ill.) 10 cols.—*Am. Engr. and Rrd. Journ.*, June, 1900.

—— *Midland Locomotive at the Paris Exposition.* Description of an express passenger engine of that company, which is distinguished by neatness and compactness of design, and embodying all modern improvements for dealing with heavy and fast traffic. (Ill.) 1½ cols.—*Mech. Engr.*, June 9th, 1900.

—— *Consideration of Weight of Parts in Locomotive Design.* By W. H. Marshall, Suptdt. of Motive Power, Lake Shore and Michigan Railway. The author indicates where savings can be effected and to what extent they can be carried. 2¾ cols.—*Am. Engr. and Rrd. Journ.*, June, 1900.

—— *Locomotive Tenders.* By William Forsyth. The author points out that of late years locomotive builders in the United States have given special attention to the building of tenders, and describes several of the more interesting types. (To be continued.) 2½ cols.—*Am. Engr. and Rrd. Journ.*, June, 1900.

—— *Modern Locomotion.* Abstract of a paper read by Sir David Salomons, Bart., M.A., before the Anglo-French Association, on May 26th, 1900, in which the author endeavours to point out what are the probable real causes of the complete change which has come over the daily life of the present generation, due to the scientific and engineering developments of our time. 3¼ cols.—*Automotor Journ.*, June, 1900.

Railways Equipment.—*The New Locomotive Repair Shops of the Philadelphia and Reading R.R., at Reading, Pa., U.S.A.* This is an account of the largest single plant of locomotive repair shops owned by any American railway and, when completed will comprise a full set of shops for foundry, blacksmith, boiler-making, and machine and erecting work for 100 locomotives. (Ill.) 3½ cols.—*Engrg. News*, May 24th, 1900.

2. New Projects.

Railways.—*The Copper Range R.R. in the North Michigan Peninsula.* Description of a railway which opens a section of the Michigan copper region, known as the South Range, which has not hitherto been worked, owing to lack of transportation facilities. 4½ cols.—*Engrg. News*, May 31st, 1900.

3. Permanent Way and Fixtures.

Tunnels.—*The Construction of the Turchino Tunnel.* Description of a tunnel on the Genoa-Ovada-Asti line of the Mediterranean Railroad Company, in Italy; the tunnel passing through the Apennines from Mele to Campoligure, having a length of 21,900 feet. 1½ cols.—*Engrg. Rcd.*, June 2nd, 1900.

—— *Progress of the New York Rapid Transit Tunnel.* Comments on the tunnel, the actual excavations for which began May 11th, 1900, and which will cause an expenditure of $35,000,000; the completion contracted for, to take place within five years. 1 col.—*Sci. Am.*, May 26th, 1900.

4. Transportation and Conducting.

5. Miscellaneous.

ELECTRIC RAILWAYS AND TRAMWAYS.

1. Trolley Lines.

Electric Railways.—*The First Cuban Electric Railway.* Description of the electric railway line, from Regla to Guanabacoa, which was opened on March 7th this year, and took the place of the steam railway, which was one of the oldest in the Western Hemisphere, running originally on wooden rails, until they were replaced by light iron rails in 1848; the track is about six miles. (Ill.) 1 col.—*Elec. Wrld. and Engr.*, June 2, 1900.

—— *A Modern German Railway Plant.* By Frank P. Perkins. Description of the Leipzic Street Railway System, which was inaugurated in 1896, and is equipped with the American Thomson-Houston trolley system, by the Union Electrical Company of Berlin. (Ill.) 1 col. —*Western Electrician*, June 2nd, 1900.

Electric Tramways. — *Southampton Corporation Tramways.* Description of the tramway system of that city, converted into an electrical one in 1898, and comprising the following routes: Prospect Place to Shirley, 1¾ miles; Prospect Place to South-Western Hotel, 1½ miles; Prospect Place to Portswood, 1¾ miles, nearly all of which are now open to traffic, and the remainder is in course of construction. (Ill.) 3 cols.—*Elec. Engr.*, June 8th, 1900.

2. Surface Contact Lines.

Electro-Magnetic Traction.—*Surface Electro-Magnetic Traction Systems.* By Frank C. Perkins. Description of a surface contact system in operation at Indian Head, Maryland, in the Naval Proving Grounds of the United States Government. (Ill.) 1½ col.—*Electricity* (New York), June 6th, 1900.

Surface Contact Systems. — *Merriman's Rising Contact Stud.* Description of an improved form of this stud, rendering it impossible, according to the inventor, for grit to work in under the treadle, and also for a passing wagon wheel to depress the treadle. (Ill) ½ col. —*Elec. Engr.*, June 29th, 1900.

3. Miscellaneous.

Electric Railways.—*The Metropolitan Railway and Electric Traction.* Description of the Earl's Court, High Street, Kensington, section of the Metropolitan Railway, which has been electrically equipped for experimental purposes. (Ill.) 1 col.—*Elec. Rev.* (London), May 25th, 1900.

—— *Central London Railway.* Description of the London underground line, recently equipped electrically, which is the most important undertaking of this kind in existence or projected. The generating station is situated at Shepherd's Bush, and extends over an area of 20 acres. (Ill.) 4 cols. (To be continued.)—*Elec. Rev.* (London), June 1st, 1900.

—— *Central London Railway.* (Continued.) The present instalment describes the four cooling towers of the Bernard-Wheeler type, the main generators of the three-plan alternating current type, the exciters and other electrical equipment of the central station. (Ill.) 6 cols. (To be continued).—*Elec. Rev.* (London), June 8th, 1900.

—— *Central London Railway.* (Continued.) The present instalment deals with the rotary converters, which form a unique feature in electric railway working. The line has, it seems, the only three-phase rotary converter sub-stations for underground railways. (Ill.) 3½ cols.—*Elec. Rev.* (London), June 15th, 1900.

—— *Central London Railway.* (Continuation.) This instalment deals with the line and rolling stock, which constitute, so to say, the essence of the scheme. (Ill.) 4½ cols.—*Elec. Rev.* (London), June 22nd, 1900.

REVIEWS.

The Strength of Materials. By J. A. Ewing, M.A., etc.: The Cambridge University Press. Price 12s.

In his preface Professor Ewing disclaims any idea of this work being intended to deal in a complete manner with the vast subject which forms its title. He states that "it is an attempt to set forth briefly a lecture-room treatment of the subject, which, to be effective, must be supplemented by laboratory and drawing office work." We may at once congratulate Professor Ewing upon the success of his attempt.

The book treats more of the mathematical aspect of strains and stresses in materials of construction used by engineers, but Professor Ewing, with the tact and judgment exhibited by those who are masters of their subject, reduces mathematical considerations to their simplest convenient form, a point which will appeal to students of engineering. We do not suggest that the mathematical formulæ used in the book are throughout of a rudimentary character, because that would be impossible, but those who know into what labyrinths of complexity a purely mathematical discussion of the stresses in structures can lead the student, will appreciate Professor Ewing's treatment of such of the problems as are discussed in his work.

After concisely explaining the now accepted meanings of stress, strain and other technical terms, the important subject of the behaviour of material after the elastic limit is dealt with. Professor Ewing draws attention to the fact that the point in the stress, strain, curve, usually called the limit of elasticity, is really only one of many limits of elasticity and that the point at which a piece ceases to behave in conformity with Hooke's law depends upon the extent and manner of its loading. It is also influenced by initial stress which may have been set up in the process of manufacture. Attention is directed to the effect of heating in tending to reinstate an elastic condition in a piece which has been overstrained, and the important influence of time in applying the load on a test piece and also the effect of rest after straining (even within the conventional elastic limit) is discussed.

Professor Ewing says that it is usual to measure the extension of a tensile test piece on a length, generally of 8 inches, in the middle portion of the piece. Of course, it is really immaterial what the exact length is as long as it is a reasonable one, but we would suggest that a standard length over which extensions are measured should be adopted, and 10 inches would appear to be convenient for many reasons. One of the earliest workers in this field in England was Dr. Alex. B. W. Kennedy, F.R.S., who always used a 10-inch length for the measurement of extensions.

A chapter is devoted to a description of testing machines, extensometers, and allied apparatus, and a large portion of the work is given up to a detailed consideration of the theory of stresses in beams and girders of various types, both simple and continuous, and allied structures. In considering the distribution of stress in a simple beam under loads which do not cause an intensity of stress greater than that coming within the elastic limit of the material, Professor Ewing says "Hooke's law is supposed to be true for all parts of the beam." We think that the experiments made by Mr. Ed. C. de Segundo in 1888, with a view to determine this point among others, may be taken to shew that within the limit of elasticity, in maximum stress, the assumptions upon which the ordinary theory of beams is based is correct, and that the stress is directly proportional to the bending moment at any section.*

The determination of stresses in frame structures by the method of sections and by graphic methods (reciprocal figures) is explained, several examples of the latter being worked out.

Struts, columns, torsion of circular and non-circular shafts, and stresses in shells and in thick cylinders, in hanging chains and arched ribs, are equally ably dealt with.

An appendix gives useful data concerning the ultimate strength of many materials used by engineers in everyday work.

We can cordially recommend this work as a valuable text book to those who are doing practical laboratory work in connection with the experimental determination of the strength of materials.

Laboratory Note-Book for Chemical Students. By Prof. Vivian B. Lewes and J. S. S. Brame (170 pp. with alternate blank pages). Westminster: A. Constable and Co., 1899.

The little volume in a very concise form, but explicit enough for all ordinary purposes, contains instructions for the laboratory preparation of gases, the reaction of metals and acid radicals, the examination of simple salts and mixtures, and for a number of suitable experiments in quantitive analysis which, if carefully followed, will be an excellent preparation for more intricate laboratory work and develop in the student familiarity with and skill in the manipulation of chemicals. The short section on the valuation of fuels, and examination of oils, although in the latter are included experiments not strictly chemical, is a decided recommendation for the little book, and the pages dealing with the examination of explosives are of considerable practical value.

* Min. Proc. Inst. C.E. Vol. XCVIII, page 308. See Table VI. in appendix.